SCIENCE

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ADDRESS OF THE PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

THE SCIENCE OF EDUCATION.

THE record of the year 1906 exhibits so many kinds and degrees of progress; such evidence of improvement in national and international well-being; such a development of the arts of peace in all lands; such exhibitions of zeal, individual and social, in behalf of corporate and governmental integrity; such abundant industrial and commercial prosperity; and finally such a universal tendency to promote education, to advance science and to foster higher standards of civilization—in short, the year just past is so full of noble endeavor, and endeavor crowned with success, that I stand almost mute in the presence of what ought to be said of the advancement of science, as science grows from more to more, and more and more is applied to the myriad arts of life.

I agree heartily with Huxley and others that there is no valid distinction between pure science and applied science. The final test of the value of what is called science is its applicability, and it is one of the signal triumphs of the last few years that much of what was rated as 'pure science,' and 'pure' because useless, has proved to be invaluable either in widening the boundaries of scientific attainment, or in the development of the useful arts.

All genuine science should be both pure and applied. In a word, let the purity and the application be taken for granted; and

[1] New York meeting, December, 1906.

let every man who finds in the formula of the mathematician, or in the formula of the chemist, or in the formula of the biologist, the key which unlocks the storehouse of nature's secrets; solves a hitherto unsolved problem of matter; or throws light upon one of the hard questions of vegetable or animal life, still claim that his science is pure, when science enables us to invent a new prime mover, to produce a new material of construction, or create a new article of food, let us give credit where credit is due—to science, and to associations which aim to advance all true science and which foster every effort to make that science useful to mankind.

The false, though inherited, notion that polite learning and true culture admit no contact with utility, is, thank Heaven, fast dying out. Occasionally a voice from the 'inner circle' shouts gleefully: "Here's to mathematics! May she never be prostituted to any human use!" But we can afford to smile at the conceit of such a Levite of culture, and pity him for his narrowness and lack of human sympathy. However, those 'pure' scientists often build better than they know. Even the professor who boasted that he had never wittingly either learned or taught anything useful has become the servant of real learning by extending the limits of scientific knowledge, which refuses to be hindered or circumscribed by its mistaken votaries.

There is, as every careful observer can testify, an abundance of useful fruit in every department of scientific research. Note the uses of electricity, chemistry and thermodynamics; of botany in fruit culture; of bacteriology in the warfare for human and animal health; and how the discoveries of science in a hundred fields is made useful in inventions for the transformation, transmission and utilization of energy.

It is not my purpose to point out the progress made during the past year in the discovery of scientific truths, and in their utilization in the various directions indicated by the different sections of this association. The task would be too great for me or for any one man. The printed reports and proceedings of the sections themselves will furnish the best permanent record. It is, however, my purpose to call the attention of the association to the importance of the science and art of education, and to suggest the propriety of creating a new section devoted to the advancement of the science of education.

THE SCIENCE OF GOOD GOVERNMENT.

Before taking up the subject which, for fifty years, has been more or less directly my life and my delight, I desire to express my estimate of the unparalleled achievement of our national government in the interests of peace and international brotherhood. I refer, of course, to our intervention, in accordance with our contract, with Cuba, to restore and maintain peace, order and good government in that long-suffering and badly-educated island. Never before, in the history of the world, did a strong nation go with an army and navy to the aid of a weak and inexperienced nationality when it was torn into factions by jealousies and distrust so deep and bitter as to overcome their desire for good order and self-government; and then, without firing a shot or taking a prisoner, establish order, disarm hostile bands, promote mutual confidence and restore the occupations of peace; and finally, having accomplished this remarkable feat, our army and navy came home again, with no booty, with no trophies, with no captives, with no triumphal procession—with nothing but the consciousness of having done an act of international good-will. The spectacle is one for the world to look upon and admire.

There is most surely a science of good government, and that science we, as a people, are rapidly advancing in this western world.

Let no one try to take away from the essential nobility of this act by pointing to the interest of a few American planters in Cuba. We are glad to have their interests protected, but those interests were relatively unimportant, and I firmly believe that had there not been an American planter or merchant in Cuba, our government's course of action would have been just the same, with the same splendid result. So let not the glory of this transaction be dimmed by unworthy detractions or by neglect. It was a great and noble work two years ago to prevail upon Russia and Japan—when those two nations stood face to face, each with an army of half a million men, ready to crush and slay till the blood of a hundred thousand young men should again stain the soil of Manchuria—to stop fighting, to withdraw their forces, and to submit the issues of their quarrel to a council of peace. That was a great work, and we glory in its accomplishment—but the work done in Cuba is not less fine, though less spectacular. Its modesty, its example of purity and restraint, of justice and respect for law, its vindication of the principles and duties of a republic—all combine to make this year of our Lord 1906 an epoch in international courtesy if not in international law.

EDUCATION IN THE ARTS OF PEACE VS. EDUCATION IN THE ARTS OF WAR.

One word more of immediate interest. The great exposition at St. Louis, in 1904, gave an epitome of the civilizations of all the nations and tribes of the earth. Their representatives dwelt or camped side by side and exhibited with marvelous fidelity and fullness their industries, their commerce, their science, their art, their systems of education and their modes of life. It was, indeed, a great educational institute carried on for seven months in the presence of millions of visitors from every nation under the sun. Probably no human instrumentality was ever more potent in promoting the advancement of science than that exposition. The great congress brought together the best of living men, and they offered their best tributes for the service of science and human progress, and we had the supreme spectacle of the triumphs of the arts of peace.

The exhibit of instruments designed to kill human beings, and of appliances for the destruction of ships and forts, was minimized, and the pageantry of war offered few attractions and claimed small attention. The glory of the exposition was its devotion to education, and the application of science to the useful arts.

I have thus characterized the exposition of 1904, in order to show more clearly what I consider an unfortunate tendency on the part of the management of the proposed Jamestown Exposition at Norfolk, Va., in 1907. I refer to the prominence which military and naval exhibits and evolutions occupy in the prospectus of attractions. The emphasis would seem to be on the science and the art of war, as though the glory of our American manhood lay in our ability to overawe, crush and destroy the very peoples who, two and a half years ago, joined hands with us and with each other in fostering the growth of an international brotherhood which should relegate the waste and horror of war to the pages of history.

Are we not in danger of cultivating overmuch a warlike attitude and of encouraging the growth of a taste for warfare? The maxim, 'In time of peace, prepare for war,' has done infinite mischief. It has misled statesmen, and sent millions upon millions of young men to untimely graves.

It means arsenals and forts, great standing armies and vast fleets of battleships; and yet those are the very things we wish to reduce to the lowest possible terms. I approve of a single military academy and a single naval academy, since both are needed by a modest army and navy; but I do not wish to see military academies multiply, nor would I have the mimicry of war become a pastime in our schools. I doubt if a correct science of education will include the science of shooting our fellow men. The episode of the early Jamestown was not a military campaign nor a naval victory; it was rather a step in the conquest of nature, and a chapter in human progress. I trust it is not too late to give to the Jamestown Exposition a tone less warlike, and to put the emphasis where it must in future belong, upon education, science, industry, commerce and social progress.

EDUCATIONAL THEORIES, ANCIENT AND MODERN.

Coming now to the special message of this address, I propose for your serious consideration the organization of an additional section devoted to the 'science of education.'

As one looks over the history of education he is struck by its chaotic condition. From Aristotle to the men now living, we find the problem of Education discussed from many points of view, with many different objects in mind, and under widely different social conditions.

The Greek idea of education and culture was based upon the existence of a privileged class, fed, clothed and sheltered by the labor of slaves—a real aristocracy devoted to war, art, literature and luxurious living. The sway of the so-called classic idea of education has been and still is one of the marvels of history. The splendor of Greek art, the brilliancy of Greek literature and the keenness of Greek logic have held the world as in a trance, unable to break away from its charms—though it has been unsuited to other peoples and other social conditions.

I need not turn the pages of history to name the writers and teachers who have risen in protest or set forth new doctrines. In many cases the new prophet or teacher has had in mind a privileged individual, or a privileged class, the education of a prince, of a nobleman, of a statesman, a monk, a scholar, a gentleman—always an exceptional person or class. The common people, the toilers in the fields and mines, the rank and file of soldiers and sailors, the builders of houses and ships, the craftsmen at looms and benches—for all such there were no educational theories. Such people had no education and they were supposed to need none beyond that gained in following the occupations or crafts themselves. The assumption was not only that there was no education suited to the common people, but that an interest and participation in the practical arts was degrading to the taste and deadening to the mind. To be sure, a Rabelais, or a Rousseau saw abundant reason for rebelling against the scholasticism of the grammarians, and advocated a return to a study of the external world and the methods of controlling and utilizing the forces of nature, but even they had no science of education, and they had small following.

THE RECOGNITON OF UTILITY AND SCIENCE.

Francis Bacon, more than any other man, showed the inadequacy of the classic method, fine as it was along certain lines, and the comparative worthlessness of scholasticism, and he opened the eyes of the educated people of his time to the wealth of opportunity for interesting and profitable study in the great laboratory of nature; and better than all else, he set forth the dignity and intellectual value of science

study—and he vigorously scouted the idea that the usefulness of scientific truth to any degree detracted from its educational value.

But none of the writers touching on education, with the possible exception of Froebel and Pestalozzi, not even Locke, Milton or Dr. Samuel Johnson, looked at the matter from the scientific standpoint which takes into account: first, the physiological laws which govern the growth and development of the brain; second, the exterior stimuli for promoting that growth most successfully; and thirdly, the kind and quantity of knowledge and skill one must have in order to meet most completely the demands of a carefully-selected occupation.

The history of education is full of the records of whims and fancies, of experiments real and imaginary, conducted in order to prove the worthlessness of some theories and the worthiness of others. Every parent has a dimly-defined theory of how his boy ought to be educated, and every teacher looking back over his own experience as a pupil formulates more or less clearly a 'system' for the proper education of his pupils. It goes without saying that such theories and so-called systems are generally shallow and inadequate, and I say this with no disrespect to either parent or teacher. I am both a parent and a teacher, and I know only too well how inevitably we theorize and plan, and how inevitably we go astray through lack of scientific guidance.

I do not claim to have formulated the science of education, and I know of no one living who has ventured to make such a claim; and yet I believe that a science of education is possible—and it is high time that we set about a systematic study of its essential features with a view to a formal statement of its main principles. Where can that important work be begun and carried on more appropriately and successfully than in the American Association for the Advancement of Science? Here we can bring the results of long experiences under a great variety of conditions, with unequaled opportunities for comparison and elimination.

In his 'Tractate on Education' Milton defined a complete and liberal education to be that 'which fits a man to perform justly, skilfully, and magnanimously all the offices, private and public, of both peace and war.' That is comprehensive enough, yet Milton had in mind only the offices which pertain to the five professions which were then open to liberally educated men, viz., those of the lawyer, the physician, the clergyman, the soldier and the gentleman. A 'gentleman' as defined by Milton was one 'who retires himself to the enjoyments of ease and luxury.' He had no thought then, as had not the educational writers of ancient or medieval days any thought, of the sixth estate, the great mass of the people who are coming to be the characteristic force in the civilization of to-day, viz., those actively doing the world's work, the constructive and distributive, and providing agencies of modern life. We are offering education to-day to every child, a comfortable home to every family, citizenship and self-respect to every graduate of our schools. The education we must study is the universal education of the American people. We have put science, and ever more science, into the world's work; we must now give science and culture and skill to the world's workers.

When a privileged class lived in luxury, relying upon the labor of slaves who were purposely and sometimes legally kept uneducated, and when education for culture and the accomplishments of polite society were natural and logical, it was not surprising that philosophers should hold that practical affairs were degrading. Seneca,

who lived in the first century, was indignant because Posidonius had so far forgotten himself as to credit philosophy with the invention of the arch and the introduction of the uses of metals.

Philosophy, according to Seneca,[1] "had nothing to do with teaching men how to rear arched roofs over their heads; and they were not concerned with the various uses of metals. She teaches us to be independent of all material substances, of all mechanical contrivances." The wise man, said the Roman Philosopher, lives according to nature. Instead of attempting to add to the physical comfort of his species, he regretted that his lot was not cast in that golden age when the human race had no protection against the cold but the skins of wild beasts, no screen from the sun but a cave in the earth. To impute to a philosopher any share in the invention or improvement of a plow, a ship or a mill was an insult. The invention of such things, wrote Seneca, is drudgery for the lowest slaves. Philosophy lies deeper. It is not her office to teach men how to use their hands. The object of her lessons is to form and nourish the soul.

The above wish of Seneca can be fairly paralleled by an utterance of Matthew Arnold in his famous essay on 'Sweetness and Light' (a phrase he borrowed from Swift). Arnold asks, with no evidence of doubt as to the superiority of the 'brave days of old':

> If England were swallowed up by the sea tomorrow, which of the two, a hundred years hence, would most excite the love, interest, and admiration of mankind—the England of the last twenty years, or the England of Elizabeth, a time of splendid spiritual effort, but when coal and our industrial operations depending on coal were very little developed?

That is, he would prefer an age when they had no mills, no canals, no steam engines, no railroads, no steamboats, no manhood suffrage, no common schools, few books, few newspapers and few magazines, because a great majority of the people of England could neither read nor write. *De gustibus non*—as I always say of Ruskin.

I have quoted Seneca at some length because he is a type of a class of people, ancient, medieval and modern, who, living like Seneca in great luxury upon their income, look with disfavor, if not contempt, upon all studies which have, or may have, a positive value in multiplying human comforts and in ameliorating human sufferings.

It is not many years since a president of Princeton University expressed his regret that the higher mathematics had been found useful in the study of electrical appliances, for, said he, 'as the utility of a subject increases its educational value decreases.' Such was the view of the fathers and the disciples of Greek philosophy from Socrates to Patton, but such was not the view of Lord Bacon, and Lord Macaulay, and Professor Huxley, nor is it your view, I trow; certainly it is not mine. I would as soon adopt the educational scheme of Machiavelli as that of Seneca. The former in all frankness and candor pictured the intellectual and moral dishonesty and hypocrisy of his time; but his life was relatively clean. As for Seneca, he sang the praises of virtue and literary culture, and then closed his career by an exhibition of meanness, ingratitude and corruption which threw a blanket of infamy over his fine advocacy of a philosophy which was to form and nourish the soul.

Is it not evident from the standpoint of the subjects to be studied that we need a science of modern education? Educational values are to be determined, taking into consideration age, sex, environment, taste, brain development and probable sphere of usefulness.

[1] Episto, 90.

THE DOCTRINE OF INTEREST.

Here two important subjects crowd upon me for consideration, and they are just the subjects which I wish to lay before a section devoted to the science of education. They are closely related, and I suspect they are strictly modern. I refer to the doctrine of interest, as a valuable or as a harmful characteristic of study; and to the wisdom or the folly of a free election of studies in our secondary schools and colleges. Consider for a moment how much we are at sea and how far we have drifted apart on these two matters—and then you will agree with me as to the need of systematic study and observation that we may find our bearings and lay our courses correctly.

The question of taste and interest is a very perplexing one. Antecedent interest is, we all know, quite accidental and a very unsafe guide. The whims of boys and girls are generally due to the suggestions of companions and of external opportunity. It has been my fortune, as well as my duty, to warn hundreds of parents of boys from fourteen to eighteen years of age not to take seriously their early interest in particular studies or their haphazard plans for future occupation.

Some choice is inevitable, and plans for the distant future are as plenty as castles in Spain, but nothing can be more evident than the unfitness of a boy in his teens to select definitely the course of study best suited to his inherited and acquired capacity; and nothing can be more certain than his practical ignorance of the conditions of a successful career. Hence his declared preferences and elections are to be treated with a loving sympathy, as are a hundred other youthful fancies, but the wise parent and the wise teacher decide to leave open all the avenues of culture and skill, and to hold off the great final choice till the boy has had time and opportunity to make two important discoveries, viz., the intellectual world within him, and the material and spiritual world without. Here we need the pronunciamento of science, telling us how much weight we shall attach to the preferences of a boy of twelve, of fifteen, of eighteen, in regard to the scheme of education and training which shall enable him to make the most of himself and be of the most use to his time and generation.

Every good teacher aims to make his subject as interesting as possible to his pupils. If they fail to take a lively interest in it, something is wrong; either it is not properly presented, or it is over their heads; or it is clearly of no earthly use. Natural lack of capacity on the part of the child is rarely a valid reason for failure, if the child be healthy and normal. I have learned to discredit the truth of the oft-told tale that 'John has no capacity for' such a subject—mathematics, for example. "He never could learn mathematics—he takes no interest in algebra and he hates geometry," etc. Our higher schools and colleges are full of young people who protest vigorously that they never could and never can understand, or take any pleasure in, or gain any profit from, certain studies. On the other hand, I firmly believe that every normal person, at least nine out of ten of the children and youth at school and college, can fairly master and actually enjoy and profit by not only mathematics, but by every subject in the curriculum, if it be properly taught, and under proper conditions as to age and preparation.

I know a man who when a boy was put too early and too rapidly to arithmetic, algebra, geometry, trigonometry and analytics. He must have had the worst possible teachers, for he comprehended nothing of what he glibly recited from memory. So they called him a dunce, reported him home as a dunce, and the boy accepted the

oft-repeated verdict and believed himself a dunce in mathematics. He would have gone through life with that conviction stamped into his brain had not chance thrown a West Point appointment in his way. Spurred by pride and ambition, he resolved to review arithmetic by himself and at least pass the entrance examination to the military academy. To his great surprise he found arithmetic easy to his maturer powers and very interesting, and he entered the military academy with flying colors. Then he took all of the mathematics which he had hated over again. They were a delightful revelation to him. He graduated among the engineers, a fine mathematician, and he is to-day at the head of an engineering school of high grade. I have the story from his lips.

I have had unusual opportunity to observe similar cases, and in a measure to help students who have been the victims of bad judgment on the part of teachers or parents, and so have been led or allowed to dislike subjects which they should have enjoyed, and to underrate their mental faculties because they had attempted to exercise brain cells which were not yet properly developed.

The importance of this subject can not be overestimated. How many lives have been shortened; how many intellects have been dwarfed and stunted; how many careers have been partial failures—all due to early and inconsiderate teaching. Opportunities to redeem and save those of great possibilities, like the one I have mentioned, are rare—and the vast majority of victims never fully recover. In our zeal we have often overshot the mark. The proverbial intellectual strength and vigor of country boys coming up to the university is due not wholly to outdoor life, physical exercise and plain food. I am inclined to believe it is due in part, and perhaps a great part, to their escape from too much schooling and too much crowding. What the country boy needs (and what he often lacks) is not so much longer sessions and rapid promotions as more accomplished teachers.

A word more about the importance of interest as a condition of healthy mental growth. I maintain that attention is as necessary to the growth and development of the brain as exercise is to the development of a muscle; and that interest is the condition of a lively attention. When in a school or lecture room the limit of close attention is reached, the lesson or lecture should close, for the educational process has already stopped. It is not only useless, but it is worse than useless, to go on when the class or audience refuses for any reason to attend. I, therefore, doubt the educational value of subjects which are not, and perhaps can not be, made interesting.

Of course I do not claim that all selected studies can be made equally interesting, or that any one study can be made equally interesting to all pupils, even when the pupils are properly graded; but I do claim that a lively interest is necessary, and that educational progress is very nearly proportional to the strength of that interest.

But all educators do not agree with me here. A Harvard professor recently wrote as follows: "The practical aim of a general education is such training as shall enable a man to devote his faculties intently to matters which of themselves do not interest him. The very fact that the abstractions of mathematics must generally seem repellently lifeless, is part of the secret of their educational value." He praises the 'elder education' which "through daily hours, throughout all their youthful years, compelled boys, in spite of every human reluctance, to fix their attention on matters which, of themselves, could never have held attention for five minutes together."[2]

[2] Professor Wendell, *North American Review*, September, 1904.

This advocacy of ten or twelve years of uninteresting studies, none of which could hold the attention for five minutes unless they were forced upon the student—as the best preparation for dealing with the interesting matters of real life, such as earning one's bread, building a home, rearing a family, contributing to the common weal, and achieving the highest success—this remarkable doctrine is the product of our own age. No ancient or medieval teacher, so far as I am informed, ever promulgated or defended it. The credit or discredit of its authorship belongs to our own day and generation. On the other hand, that veteran and very sensible writer, John Locke, two hundred and fifty years ago, said: "The great skill of a teacher is to get and keep the attention of his scholar. To attain this, he should make the child comprehend the usefulness of what he teaches him, and let him see, by what he has learned, that he can do something which he could not do before; something which gives him some power and real advantage."

I join Professor Wendell in discounting the whims and fancies of children, and in his estimate of the value of an unintelligent choice of studies; but we must part company when he would force me to accept the doctrine that I must be careful not to make my mathematics and mechanics very interesting, lest their educational value be impaired. May I not refer this matter also to a section on education?

FREE ELECTION OF STUDIES.

Closely related to the above is the great question of elective courses of study in our colleges. Personally, I am less concerned with this, since in the school or college of engineering with which I am connected, the curriculum is carefully laid down, and there is no election till the end of the freshman, and generally not till the end of the sophomore, year—and even then only a single election of a carefully prepared line of study is allowed. But I have been a more or less interested observer of the working of a free elective system elsewhere. I am not now going to discuss it, or to weigh it in the balance of experience. Such a discussion of its theory and practise would occupy a full paper before an educational section. Science teachers and scientific men are, or should be, deeply interested in this matter, for, if I mistake not, the rush for certain branches of science, and away from the traditional studies, has led in many cases to the calling of a halt in the freedom of election. My own conviction is that the pendulum has swung too far. The number of required studies should be increased and the later years should be given to a group of subjects selected from a list of groups prearranged by the faculty. It is perhaps not quite safe to condemn a system which permits a student, having entered college on substantially the old requirements, to go through and graduate with honor, without giving during his entire college course a single hour to any one of the three corner-stones of the old curriculum of my college days: Latin, Greek and mathematics—but it certainly raises a question in the mind of every reader of educational history. Is there not a golden mean between predestination and free-will in the matter of studies and educational values?

OTHER EDUCATIONAL QUESTIONS—ATHLETICS.

Never, since the days of Grecian games at Olympia, has physical culture, including field athletics, been so prominent a feature of student life as now. We can truthfully say that to-day athletics is the most conspicuous part of an academic education. Unquestionably the curriculum is out of balance, and a readjustment is necessary. The healthy, normal boy (and I may add, the healthy normal girl) requires and enjoys vigorous exercise in the shape of

games. While I advocate rational athletics, I deeply deplore semi-gladiatorial exhibitions which put the emphasis in the wrong places, and which mislead and demoralize the entire student-body. There has been a drift backward of late years towards a species of barbarism, which we had fancied we had outgrown. It becomes scientific men to restore, or better, to establish, a condition of educational equilibrium.

I can not even mention all the matters of prime importance which would speedily come before an educational section. The organization and functions of boards of education are matters of the greatest moment at the present time, and I suspect they have a perennial interest. It is already on the program of one of your sections.

Some thirty years ago kindergartens were incorporated into the course of instruction of the public schools of St. Louis, and later into the schools of many other cities. The constitution of the state of Missouri—very unwisely, I think—does not allow children under six years of age to attend any form of a public school; yet we shall all agree that the best kindergarten ages are the fifth and sixth years. Nevertheless, nearly every child in St. Louis for the last thirty years has attended kindergarten during his entire seventh year, taking up the primer for the first time upon entering the 'first grade' when seven years old.

In spite of occasional protests and claims that valuable time is thereby wasted, the plan is fairly popular and there is no near prospect of change. The later progress of the relatively mature children in the first grade is remarkable, and many observant principals think that ultimately no time is lost. As for myself, my judgment is in suspense, and yet I have sent five children to the kindergarten. It is always difficult to compare what has been with what might have been, and with what would have been, had things been different. Suppose I refer this all-important matter to scientific educators.

PHYSIOLOGICAL PSYCHOLOGY.

Perhaps the most valuable contribution to the science of education has come through a study of the laws which obtain in the growth and development of the brain, and the conditions under which that growth and development is most healthy and complete. There are times and seasons for the development of the mental and moral faculties as there are of the physical faculties. While such times and seasons are not precisely the same for all children, we find that all attempts at premature development are not only worthless, but are permanently injurious. Precocity is now regarded as a species of brain deformity. Plants and animals may be forced, and unusual and interesting results may be produced by forcing, but no one of us wishes a son or a daughter to be a prodigy in one direction at the cost of normal development in other directions.

The psychologists tell us that the brain cells develop as do other physical organs, not only through thought, but through muscular activity and the exercise of our senses. Accordingly, a healthy and timely growth and development of the brain is to be promoted by an education involving a great variety of activities, skilfully adjusted as to quality and quantity to the mental and physical status of the child. I have often thought, when candidates for admission to Washington University present themselves, that, instead of asking them several sets of questions on a variety of somewhat conventional subjects, I would like to take off their skulls and brain coverings, and see how fully their primal brain cells were developed, and the extent to which the network of intercommunication between cells had been established and was

in good working order. Such an examination would tell far more than any mere written examination. To be sure, I might find it difficult to read and interpret what would be written there, but the record would be there to the minutest particulars.

This branch of my subject outruns both my time and my ability. But there are experts, and they are veritable men of science, and they are most welcome to the companionship and fellowship of this association.

MANUAL TRAINING.

Closely related with this of brain culture is the subject of manual training, which has recently gained a foothold in our scheme of rational education. Its nature and educational value are still under discussion. This relationship is well shown in a paragraph which I take from one whom I am always glad to quote.[3] Said he:

> In man, the size of the motor area in the brain depends far more on the complexity of the movements affected by a group of muscles, and on the fine coordination of these movements, than on the mere mass of the muscles involved. Physical energy implies a good motor brain area. The man of energy is a man of brains, no less really than the man of thought.
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> Physiologists distinguish muscles as 'fundamental' and 'accessory.' The fundamental muscles are the large masses of muscles used in locomotion and in performing movements requiring strength rather than fine adjustments and delicate coordinations. They are, for the most part, the muscles which we have in common with the lower animals and which we have probably inherited from our forefathers who dwelt in trees. The accessory muscles are those which involve fine coordinations. They are principally the muscles of the forearm and hand, and those of the vocal organs. Now it might be argued that manual training is not necessary for the development of the motor centers in the brain, on the ground that gymnastics and outdoor physical exercise are quite adequate to accomplish it. The answer to this objection is the fact that gymnastics and physical exercise in general, appeal almost exclusively to the fundamental muscles and their brain centers, and rarely to the accessories. Nothing short of manual training will reach effectively the important brain cells governing the fine motor adjustments of the muscles of the hand, as nothing short of actual speaking and actual singing can ever effectively develop the equally important brain cells governing the muscles of the vocal organs. The motor cells of the brain controlling the muscles of the joints nearest the trunk develop first, and later, in regular order, those which control the muscles of the more distant joints. Education ought to follow this order of growth; it should avoid training the fingers to make finely coordinated movements at a period when nature has not yet got beyond developing brain cells to make the coarser adjustments of the shoulder and elbow joints. Physical training, which appeals to these more fundamental muscles of the proximal joints, should at first precede manual training, which appeals especially to the muscles of the forearm, hand and fingers.

[3] Professor Thomas M. Balliet, of the University of New York.

We have in the above statement a scientific explanation of the educational value of manual training, so far as it relates to the growth and development of the brain.

As some of you know, I have had something to do with the introduction and defense of manual training as an educational feature. There was from the first no question of its economic value to the great mass of American boys, and largely for that reason it met with favor among people who were more concerned with the work the boy would be given to do after his brain and hands had been developed, than with the means and activities by which the finest and most useful development of the whole boy could be secured.

A study of the whole field of education, classical and technical, led me, in 1879, to organize a school for boys of high-school age in which manual training should be combined with intellectual training; to put the liberal arts and the mechanic arts side by side in the same curriculum; to deal simultaneously with material forces and appliances and with spiritual forces and appliances; to cultivate not alone or chiefly

the memory and the understanding, the eye to read and the mouth to speak, but the judgment and the executive faculties as well; to extend the humanities so as to include human interests and human activities as they exist now and here. Many wise and excellent educators had grave fears as to the result of the experiment. It was thought that the introduction of tools, machinery, materials, the theories of construction, and draughting, might not only break up the orderly program of the school, but they would lower its intellectual and moral tone. It is now known that all such fears were groundless. Manual training, when properly adapted to the boy's status of brain development, and when incorporated into the daily and weekly program with due regard to the other essential features, has proved to be a more valuable element in education than even the most sanguine advocate dared to expect. The moral, intellectual and economic fruit of this combination, as shown in the characters and careers of the boys who formed the first classes in the pioneer schools, is the best possible evidence of its value. The gloomy predictions made of its effect upon the pupils, and upon our American system of schools, have been forgotten, and early opponents are fast friends and enthusiastic advocates.

This is no place nor time for me to give an exposition of manual training; I have preached its gospel elsewhere and often. But I mention it as one of the important matters which must be carefully weighed and adjusted. We must defend it from frivolity on the one hand, and from misdirection and undue emphasis on the other. At first it was suspected that our motives were sordid; that we were likely to degrade our schools, to teach narrow trades, and to turn out 'mere mechanics' instead of educated men. On the other hand, a recent report of a Massachusetts commission (for whose membership I cherish high respect) regards the manual training movement as almost exclusively educational and not sufficiently industrial. I suppose the earlier and the later estimates are still held by many sincere and able teachers. One does not easily lay aside the convictions of a lifetime. The manual training movement stands inevitably as a criticism upon the system of education which came down the ages through the fathers to us, and naturally the latter stands on the defensive. It is also a standing reproof to the old wasteful, unscientific method of teaching to apprentices the theory and uses of tools. It is for educational science to justify the ways of progress which lays aside the idols of the past and erects new temples and opens new kingdoms. Of all the temples, none is finer, none is more glorious and none should be more scientifically planned and reared than that of education. While no section of this association can enforce the dictates of science, it would be helpful if we were able to establish these two things as true, viz:

1. That usefulness does not impair educational values.

2. That a so-called culture-study like Latin may properly stand side by side with manual training in the curriculum.

We are all pleased (though perhaps surprised) when we learn that a man who reads blue-prints, and can make and use a diamond-point machine-tool, is also a linguist and at home in the calculus; and yet we are more than likely to assume that the boys who are studying the theory and use of tools have little need of literature; and that the student of the classics is wasting his time in a laboratory of the mechanic arts.

"What are these boys studying Latin for?" said an English visitor at the manual training school as he looked in upon a class reading Cæsar.

"What did you study Latin for?" was my illogical but American response.

"Why, I am a bachelor of arts!" was his prompt reply, with the air of one who had given a conclusive answer.

"Perhaps these boys will be bachelors of arts by and by," I added cheerfully.

"Then, what in the world are they in a manual training school for?" he exclaimed, with almost a sneer at my evident lack of acquaintance with the etiquette of educational values.

I tried to explain my theory of an all-round education—and my practise of 'putting the whole boy to school'—but he would not be convinced. He could not see the propriety of mixing utility and tool dexterity with culture. Our visitors are not all Englishmen; yet I venture the estimate that fully one half of the bachelors of arts who look through our study rooms and our work rooms have about the same prejudice as the Englishman had, though they do not so openly express it.

THE NEW EDUCATION.

The evolution of the fully fledged technical school, or the technical department of the university, has taken place during the last half century, and yet its broad stimulating, attractive features have a following which bids fair to double the attendance of college and university students. This does not mean that letters and polite learning are being neglected, but that a new constituency is eager for the new education. This new education, though it recognizes at all points a high order of usefulness, and contains little that is conventional, is only remotely professional. If ever its curriculum becomes narrow, it is quickly condemned by the best representatives of an education which combines utility with culture. No longer can the 'Levites of culture,' as Huxley calls them, claim to monopolize liberal education. The new education can be as liberal as the old, and both can be narrow. Fortunately, they flourish side by side and the future shall choose the excellencies of each. An adequate science of twentieth-century education will evaluate the characteristics of each, and bring the wisdom of the past, not its foolishness, to nourish the wisdom of the future.

In conclusion, let us not fear to lay the foundations of the science of education broad enough to carry and to advance our twentieth-century civilization. Let us not fear to strike out for ourselves when the age presents new demands. Progress is essential to life, as Browning says:

> What comes to perfection perishes.

I see nowhere, in either ancient or modern times a people whose youth have been trained as our Americans should be trained. Neither Greece nor Rome with their pinnacles of culture resting on the barbarous foundation of human slavery, nor the blooded aristocracies of modern times, can teach us how to educate, train and adorn an American citizen. We must not expect all our students to rule, nor yet all to be ruled; to direct, nor yet to be directed; to employ, nor to be employed. They must be capable of all these things. No narrow, selfish aim, no prejudice of caste, no false claim of high culture which scorns service, must mislead the growing, expanding minds. Give them a generous, symmetrical training; open wide the avenues to usefulness, to happiness, to power; and this age of scientific progress and material wealth shall be also an age of high intellectual and social achievement.

CALVIN M. WOODWARD.
WASHINGTON UNIVERSITY.

SCIENTIFIC BOOKS.

The Nervous System of Vertebrates. By J. B. JOHNSTON, Professor of Zoology in West Virginia University. Pp. xx + 370; 180 figures. Philadelphia, P. Blakiston's Son and Company. 1906.

The study of comparative neurology has always been regarded as difficult, often as uninteresting and sometimes as unprofitable. However much we may ameliorate the first of these difficulties by improved pedagogic devices, we can not hope to make much progress in this direction until the stigma implied in the second and third is eliminated. The mere descriptive anatomy of the nervous system is truly uninteresting and, like any other uncoordinated mass of intricate detail, relatively unprofitable. Only in so far as the nervous system can be described in terms of its functions has its study any value from any point of view; and it is in respect to just this correlation that the past literature of neurology (both text-books and monographs) has been notably weak.

The technique of modern neurological research is so very difficult and diversified and the mass of intricate anatomical detail which must be carried in mind during the progress of investigation so vast, that the neurologists have not, as a rule, been able to control their anatomical findings physiologically as the work progressed. Though anatomical research normally precedes physiological, yet the gap between them can not properly be left so wide as neurologists have been inclined to leave it. Even in pathology, though a few years ago there was a vigorous movement toward a correlation of anatomical and clinical observation, yet the results were disappointingly sterile, and now the tendency is to lay more emphasis on clinical work alone, leaving anatomical research to be cultivated apart by specialists in that field. This surely is not a creditable situation. And though it would doubtless be unjust to place the responsibility on any one specialty alone, yet clearly the anatomists must carry their full measure. For it should frankly be recognized that, though neurology has contributed much to physiology, psychology and psychiatry, yet the direct positive help given to these sciences is not at the present time commensurate with the vast accumulation of laborious research represented in our literature of neurology. And this is particularly true of comparative neurology, which should logically lead in practical fruitfulness.

Professor Johnston's manual strikes at the root of this evil. It is a text-book of functional neurology. The unit of his descriptions is the functional system of neurones, that is, the aggregate of related neurones which cooperate in the performance of any given type of reflex movement. The analysis of these functional systems is a matter of extreme difficulty, involving the collective use of various refined anatomical and physiological methods, but it is obviously so much easier in the brains of lower vertebrates than in the human brain that the comparative method has been here most fruitful. After four introductory chapters, Johnston devotes himself in the remainder of the book to an exposition of the functional divisions of the vertebrate nervous system and their phylogenetic history. The style is direct and clear and the illustrations numerous, so that the student who is equipped with an elementary knowledge of vertebrate anatomy and embryology should be able to follow the author, even though his method and subject matter are for the most part distinctly different from those of the other text-books in general use.

Chapters five to thirteen include the definitions and tabulation of the functional systems, followed by a detailed description of each and its phylogeny. Chapters fourteen to nineteen follow with a similar exposition of the structure and evolutionary history of the centers of correlation, including the cerebellum, mid-brain, thalamus, fore-brain and neo-pallium. These fifteen chapters taken as a whole constitute the most ambitious attempt which has yet been made to elaborate a phylogeny of the vertebrate nervous system. At no time previous to this could such an endeavor be expected to yield more than a limited measure of success; but by basing his phylogenies upon functional units of internal structure instead of superficial external features the author has succeeded in demonstrating the unity of plan of the vertebrate nervous system with gratifying completeness and in showing that this plan is unexpectedly simple. All of the important known stages in the evolutionary his-

tory of these functional systems are illustrated by clear diagrams. The mastery of these simple diagrams will give the student the principal landmarks for all of his subsequent study of cerebral morphology.

While this work is primarily a text-book of the morphology of the nervous system, its great merit lies in the fact that its facts so far as they go also express the functions of the parts, so that comparative physiology and comparative psychology will both find in it an immediate point of departure for their special researches. It will form the natural preparation for such courses and also for courses in human neurology, for it is not designed to take the place of any of the manuals on the human nervous system. Very little space is devoted to the human brain alone except in the chapter on the neo-pallium, yet every chapter is essential to the comprehension of the corresponding human structures, a claim which can hardly be made for any previous work on comparative neurology.

This book is an outgrowth of the work on nerve components inaugurated by the American school of comparative neurologists and no estimate of the validity of the conclusions arrived at is possible without a study of the series of memoirs on nerve components and functional divisions of the brain upon which it is based. This work is still so incomplete that any attempt to summarize its results is necessarily fraught with the dangers of too hasty generalization. And it would be rash to claim that all of Johnston's suggested homologies will stand the test of time. This much may be said, that they are not out of harmony with the facts as at present known, and where his conclusions can not be regarded as definitely proved they are sure to be stimulating and helpful in pointing the way toward the truth; for the basis of the work is sound and the leading conclusions abundantly supported by the singularly concordant results of the studies of the new school of comparative neurologists.

C. JUDSON HERRICK.
DENISON UNIVERSITY.

The Loose Leaf System of Laboratory Notes. By THEO. H. SCHEFFER, A.M., Kansas State Agricultural College. P. Blakiston's Son and Company.

The laboratory note-book is a subject of more or less interest and importance to every laboratory teacher. In some cases its value may be underestimated, and as a consequence the note-book, as an index of the laboratory work of the student, is an almost negligible quantity. On the other hand, there is the tendency to exaggerate its value and overestimate its importance, with the result that it may become the inflated repository of elaborate compilations from every available source, including elaborately detailed drawings, artistically executed, and involving an immense outlay of time and energy, and finally bound up in morocco covers.

Between these extremes are to be found all sorts of intermediate ideals and practises, somewhere among which the 'Loose Leaf System' under review may be listed. Briefly distinguished, it consists of a series of printed laboratory directions for the study of some twenty-one types of animals, from protozoa to birds, the whole loosely tied up in binders' boards, and so arranged as to allow the inclusion of the students' notes in connection with directions given for each type.

So far as the directions themselves are concerned they furnish about what every laboratory teacher provides, namely, a manual of directions, either printed or typewritten, to facilitate and systematize the students' work. The directions here provided furnish a fairly adequate outline for an elementary course in zoology of perhaps a single semester. The chief criticism, from the writer's point of view, is that the directions follow too closely the *verification* method of the older manuals, rather than the *interrogatory* method; that is, the student is too fully advised as to *what* is to be seen and *how*, instead of suggestively presenting him with a series of problems for solution, or opening before him avenues of discovery.

In general, the subjects are well presented, and with comparatively few errors of statement. One such may be pointed out in connection with the study of the medusa, *Gonionemus*, where it is said that 'like all hydroid

medusæ it buds off from plant-like masses of fixed hydroid polyps.' As a matter of fact, this medusa forms a conspicuous exception to the general rule and does not arise by budding, as in *Obelia* or *Pennaria*. The typography and press work are excellent. The mode of binding is, however, far from ideal. Much better covers for such notes are now provided, which are far simpler and more effective than the rather crude 'shoe-string' method used in this book.

C. W. H.

The Subconscious. Joseph Jastrow. Boston and New York, Houghton, Mifflin and Co. Pp. ix + 549.

This book is not so much a theory of the subconscious or an analysis of the concept of subconsciousness, as an attempt to schematize certain portions of normal and abnormal psychology, on the basis of a definite assumption of a subconscious, the conception of which, however, is very indefinitely outlined. The course of the whole exposition is directed toward a specific development of a familiar theory of the self. The treatise throughout is furnished with a wealth of illustration which may be of use to the instructing psychologist, but it is embellished with a profusion of metaphor, simile and analogy, which, under the author's mastery of polysyllabic verbiage, gives rise to a florid fluency apt to cause the newly introduced reader to lose the path of the argument amidst the rhetorical gardens which surround it.

In the ten chapters of Part I., which deals with the normal consciousness, the author takes us through an elaborate exposition of the doctrines of habit, attention, automatic action, will and self-consciousness, with which we have been made familiar by James. This part seems apt to be found of much use for students covering intensively these topics of psychology.

It is in this part, however, that the concept of the subconscious (or perhaps we should say the term subconscious) is made a useful basket for the reception of the odds and ends left loose by more timid authors. First is shown how processes go on without consciousness. Then in Chapter VI. (The Mechanism of Consciousness) is assumed a subconscious control without definite definition of the same, and the 'apportionment of mental life to the subconscious and conscious participants' is discussed, the topic being continued through the succeeding chapters.

In the course of this discussion, not only are various types of automatic and habitual action handed over to the responsibility of the subconscious, but active recall, and spontaneous trains of association in sleep or waking, are construed as the 'bringing of the subconscious activity to bear for the service of the conscious.' The associative mechanism in general is said to 'find its sphere of activity largely in the subconscious realm.' Self feeling is said to be strongly tinged with subconscious elements; subconscious feelings of our own importance, of the attitude of others, etc. By way of strengthening the useful concept, the experimentally ascertained effects of imperceptible stimuli on consciousness are cited.

So far, the term subconscious covers the general field of (1) unconscious control of activity, (2) production of conscious effects by factors not themselves in consciousness, and (3) vague consciousness.

In Part II., which deals with abnormal phenomena, dreams, hypnagogic hallucinations, deliria, drug intoxications, somnambulisms, hypnotic states, hysterias, and alterations of personality, or the psychological side of these, are considered and described on the basis of the same concept (or term) of the subconscious. The principal factor in these abnormalities is almost stated to be the dominance of the subconscious as over against the dominance of the conscious in normal experience.

In general the rôle this subconscious plays is shown as identical with that in the actions, perceptions and associations of normal consciousness. The important new phases which are reduced to a basis of subconscious activity are: (1) anesthesias, which are shown to be not physical losses of sensibility, and to be even psychically contradictory, (2) confusion of hallucination with reality, and (3) the loss of conscious control over actions which yet go

on with physical perfection and certain teleologicality, and are somehow registered. The standard cases of alteration of personality are cited in some detail, but their bearing on the general problem, aside from their nature as extreme cases of dissociation, is not made clear.

This part of the book is rather a miscellany of illustration and comment which might be interesting to the lay reader, than a systematic treatise available for the student.

In the third or theoretical part the author goes again over the whole field, discussing the participation of the subconscious, and raising the question of its status, but evading any answer more definite than that it 'though not in consciousness may be said to be of it.' In the second part he expressed his belief that dissociation involves a 'central dominating agency from which the dissociation takes place,' that an experience is made ours only by a synthetic 'act of incorporation,' and that the nebulously conceived subconscious is the 'non-personal, non-synthetized' experience. To this factor of selfhood he now adds two others, leading finally to the statement that it is the privilege of the psychic experience to arouse a realization of its place in the series (*incorporation*), and of the background that is passing (*orientation*), and of the fact that it is moving (*initiative*). Such realization involves the conception of a conscious self. Anesthesias of abstraction, somnambulism, hypnosis and hysteria are 'practical symbols' of impairments of incorporation, 'a state of mind in which the psychic movement persists, but without obtaining normal acknowledgment.' Loss of orientation manifests itself characteristically as confusion of subjective and objective: the crediting of hallucination as in hypnosis, delirium and hysteria, being consequent on anesthesia, which cuts off the normal corrective judgment on which orientation is based. Light forms may be mere bewilderment or doubt. Impaired initiative is 'impulsion' or loss of control over motor activities, as in automatism. The typical form is 'substitution for spontaneous action of an impulse imposed from another source than the directive will.'

These three realizations are the characteristics of self, and therefore, when they are impaired, the self is impaired. The various abnormalities previously treated lend themselves very nicely to generalization under these heads, which, however, to the reviewer seem to add very little to the explanation or better understanding of the phenomena.

The general course of the schematization in terms of the three components of selfhood would lead us to expect a vital impairment of all three in decided alteration of personality. 'With the conjoint impairment of all, an altered state (of the self) is induced,' the author says, but comes no nearer to an analytical application to the cases of alteration cited in Part II., leaving us, therefore, to be content with the inference that although 'conjoint impairment' *would* produce decided alteration of personality, the typical and accepted cases depend entirely or largely on 'loss of incorporation.'

In spite of the few criticisms above incorporated the book is a strong and interesting one, displaying the extent and intent of Dr. Jastrow's grasp on the field which it covers. It is to be hoped that the volume is what it appears to be, namely, an expression of intention or preliminary filing on the said field, and that it will be followed shortly by a more exact and basic work from his pen, a contribution which would be highly appreciated by all students of this obscure portion of the psychological domain.

KNIGHT DUNLAP.

SCIENTIFIC JOURNALS AND ARTICLES.

Bird-Lore for November-December opens with an account, by Edgar F. Stead, of 'The Wry-bill Plover of New Zealand,' the only bird in which the bill is noticeably bent sidewise. It is stated that this bird is dying out without apparent cause. Other articles are 'Our Garden Mockingbird,' by Mrs. F. W. Roe; 'Tame Wild Geese' (visitors to Golden Gate Park), by W. K. Fisher and 'Italian Bird Life as it impresses an American Today,' by F. H. Herrick. This might better be called, the *absence* of bird life, small birds being scarce in Italy, their place as insect

destroyers being taken by lizards. W. W. Cooke gives the seventeenth, and last, paper on the 'Migration of Warblers.' It is noted that the colored plates of warblers will be followed by those of the thrushes, and these in turn by the flycatchers, it being the laudable ambition of the editor to figure in time (a slip in the types makes it in the next volume) every species of North American bird. The number contains the Annual Report of the Audubon Societies, which shows a gratifying increase in bird protection throughout the country, though much yet remains to be done in arousing public sentiment in favor of protection, and the enactment and—what is more important—the enforcement of laws.

The Museums Journal of Great Britain for November contains articles on 'The Significance and Scope of a Museum in Lienz,' by A. B. Meyer, being advice as to the objects and administration of a local museum; 'The Equipment of a School Museum,' by Oswald H. Latter, showing the museum from the teacher's point of view; and, under the head of 'International Bureau of Ethnography,' a free translation of the memorial adopted by the congress at Mons, Belgium, in 1905. The object of the bureau, which is to be established in Brussels, is the organization at common expense, of services pertaining to the scientific documentation relative to the social state, the manners and customs of different peoples, especially peoples of inferior civilization.

The Geological Survey of Canada has recently issued a 'Catalogue of Publications' that forms a most acceptable addition to the literature of geology. It is divided into various parts, the first containing 'Reports of Progress, Annual Reports and Summary Reports in Order of Publication.' Part II. contains 'Publications arranged according to Locality'; Part III. contains 'Authors' Reports,' arranged alphabetically; Part IV. is a list of reports according to their principal topics, economics, paleontology, etc.; Part V. comprises the 'Principal Reports in the Director's Summary Reports since 1894'; Part VI. is devoted to 'Reports on Economic Subjects included in the Reports of the Mines Section' and Part VII. is a list of maps.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

The 418th meeting was held on October 20, 1906, President Knowlton in the chair and about fifty persons present.

Dr. Evermann called attention to the capture last August (28) of a Pacific Chinook salmon, weighing 5¾ pounds, in Sunapee Lake, N. H., the second example of this species known to have been taken in Atlantic waters. This is the result of the introduction by the State Fish Commission in the spring of 1904 of fry hatched from eggs furnished by the U. S. Bureau of Fisheries. The bureau has made numerous plants of Chinook salmon in eastern waters, but, though a 14-pound specimen was caught in Lake Ontario several years ago, had despaired of establishing the species, and had begun to introduce the silver and humpback salmon with which it feels more confident of success. The Sunapee specimen was not over two and a half years old, and it seems probable that the conditions in that lake are favorable and will result in the permanence of the species on the Atlantic side.

Dr. Rose exhibited a photograph and specimen of a very curious compact desert plant[1] which resembled a giant puff ball, but with corky bark and grass-like leaves. The plant was introduced into England sixty years ago, but female flowers and fruit had never been collected until found by Dr. Rose in Mexico in 1905. These show that the plant is near Nolina and Dasylirion, but of very different habit and fruit.

Mr. Piper showed a specimen of the Japanese 'hagi,' a plant, *Lespedeza bicolor,* from the Arlington farm, and called attention to the peculiar form of fasciation which consisted in the flattening of the branches.

Mr. W. J. Spillman presented a paper on the 'Mechanism of Heredity.' It was pointed out that our present knowledge of cytology apparently enables us to form a satisfactory theory of heredity. The fundamental assumptions necessary to the theory are as follows:

1. The chromatin is the material in which hereditary qualities inhere. This assumption

[1] '*Calibanus*, a New Genus of Liliaceous Plants,' Contr. Nat. Herb., **10**: 90, 1906.

accords with the views of practically all biologists.

2. The chromosomes retain their identity. This assumption has been arrived at independently of any theory of heredity, and represents the opinion of many investigators. It has not, however, been fully established. In case it is shown that the chromosomes do not retain their identity, the reasoning by which the present theory of heredity is developed may be applied to the subdivisions of chromosomes which are the ultimate biological units, so that the theory, in its essential outlines, is independent of the theory of chromosome individuality.

3. Synapsis in organisms exhibiting alternate inheritance consists of the union of homologous chromosomes received from different parents. This is the view arrived at independently of theories of heredity by the majority of investigators.

4. If the chromosomes themselves are the ultimate biological units, in the first postsynaptic division the position of bivalent chromosomes is so far governed by chance that any given segment of the bivalent is as liable to go to one pole as the other. This conclusion was arrived at by Sutton independent of theories of heredity, and its possibilities have been pointed out by Cannon, Boveri, Wilson and others, who have also called the attention of the relation of this phenomenon to the laws of alternate inheritance.

If independent unit characters reside in the same chromosome, alternate inheritance shows that two homologous chromosomes must exchange character determinants. There is no cytological evidence of such exchange. It is admitted as a possibility. If it does occur, the theory here developed will apply to character determinants consisting of subordinate constituents of the chromosomes as it is here developed for the chromosome itself. Since there is evidence of the chromosome distribution called for by alternate inheritance and no evidence of such distribution of parts of chromosomes, we accept tentatively the simpler assumption that chromosomes retain their identity and are the bearers of hereditary characters. The following facts follow as necessary consequences of the above assumptions:

Two characters inhering the same chromosome are transmitted together. Cases of such gametic coupling of characters were cited. The facts of alternate inheritance and of evolutionary changes are made clear without resort to ids, pangens or other elements subordinate to the chromosomes themselves. Illustrations were given of the mechanism by which Mendelian characters, both simple and compound, are distributed to progeny.

Many mutations may be accounted for as the sudden appearance of characters which have developed through an indefinite period unsuspected until a chance cross revealed their identity. Examples of such characters were given.

Mendelian unit characters are, for the most part, non-essential characters. When vital characters attempt to become Mendelian, which they continually do, they lead to elimination by natural selection.

The chromosomes of a given nucleus are not essentially differentiated with regard to vital characters. That is, vital characters are functions common to all chromosomes, and hence do not obey Mendel's law, but a different law, which was stated.

Mendelian unit characters (simple characters) are functions of single chromosomes or a single pair of homologous chromosomes. (Homologous chromosomes are those that unite in synapsis to form a bivalent and are supposed to relate to the same characters.) Homologous chromosomes are of common recent descent.

Non-homologous chromosomes are not of common recent descent, but are of common descent in the distant past.

Synapsis and reduction require the finest adjustment of function of any office performed by the chromosome, as shown by the sterility of hybrids. Hence, organisms that interbreed freely must vary together if they vary at all. Isolation (cessation to interbreed) is, therefore, the prime condition in the differentiation of species.

Natural selection affects evolutionary changes in the following ways:

1. Homologous chromosomes must retain sufficient similarity of function to function together in synapsis and reduction. They may vary in function, but must vary together.

2. Non-homologous chromosomes must function together in mitosis and in synapsis and reduction. Hence, if they vary in a given interbreeding group, they must vary together within narrow limits.

3. Chromosomes must not disagree in the expression of vital characters to such a degree as to interfere with the development of a perfect organism.

4. In non-essential characters that do not interfere with proper functioning in mitosis, synapsis, and reduction and in the development of a perfect organism, chromosome functions are free to vary.

5. If a change in the expression of a character changes an essential relation between the organism and its environment, natural selection favors or retards variation according as the variation affects the relation to environment favorably or unfavorably (protective adaptation, for example).

6. Chromosome variation is limited by the constitution of the chromatin itself.

Organisms that reproduce asexually are freer to vary than others. An organism continuously propagated by cuttings may, by unrestrained variation of chromosome function, lose the power of sexual reproduction, *e. g.*, the banana plant. Presumably, variation is here so rapid as to secure the advantages ordinarily conferred by sexual reproduction.

Evolutionary changes may, in general, be accounted for as the result of slow, gradual changes in the functions of the chromosomes. It was shown, however, that bud variations are possibly marked changes in chromosome function due to a new adjustment between the constitution of chromatin and the food supply or other elements of the environment. Presumably, such changes are most likely to occur in forms propagated asexually, and especially when propagated under conditions of forced growth, where the food supply is abnormally large. Bud variations may possibly be correlated with changes in the numbers of chromosomes.

It was pointed out that a widely distributed species might present a series of forms, adjacent sections of which might differ so little as to interbreed freely, while the extremes, if they met, might not be able to interbreed at all.

In the discussion which followed Dr. O. F. Cook pointed out that the doctrine of the permanent identity of the chromosome has not been established, and that the indications of the more recent cytological research were against it. Mr. Spillman replied that a different interpretation might be placed upon the cytological phenomena cited by Dr. Cook.

In response to a question by Mr. M. B. Waite, whether the view set forth by Mr. Spillman, in addition to explaining geographical species, would not tend also to explain what a species is, Mr. Spillman replied that the theory formed important evidence on this question, stating that while specific distinctions differ in different groups and in the minds of different investigators, we might go so far as to say that two groups which can not interbreed must be distinct species. Even if they do not present morphological differences that will permit their identification variation will soon bring about such differences in the absence of interbreeding. On the other hand, the term species has acquired such a meaning that we can not state that two groups that can interbreeed are the same species. Inability to interbreed may be taken as the outer margin of the field of specific distinction.

Mr. Doolittle cited as examples analogous to that of the goldenrod referred to by Mr. Spillman (as a widely distributed group adjacent sections of which interbreed but extreme forms of which might not interbreed) certain species of rodents described by Dr. Merriam, and Dr. Stejneger mentioned two butcher birds (*Lanius*), subspecies in Central Asia which came together by different routes in the Scandinavian peninsula as separate species.

M. C. Marsh,
Secretary.

THE TORREY BOTANICAL CLUB.

The meeting of the club on November 13, 1906, was called to order by President Rusby

at 8:15 o'clock, at the American Museum of Natural History.

The following scientific program was presented:

Account of a Collecting Trip in the Adirondack and in the Catskill Mountains: Dr. PER AXEL RYDBERG.

Dr. Rydberg gave an account of botanical field studies and collecting in the regions mentioned, giving special attention to the blackberries. The talk was richly illustrated by herbarium specimens collected on the trip.

Remarks on the Flora of China: Dr. AUGUSTINE HENRY.

Dr. Henry gave a very interesting account of some features of the flora of China, pointing out its richness and great diversity, which are correlated with diversity of topography and climate, and emphasizing both the slight amount of collecting that has as yet been done there, and the important results to be obtained by ecological and systematic studies in that region. As an illustration of this he called attention to the fact that several genera, recorded in existing manuals as monotypic, are known to be represented in China by several distinct species.

THE club met on November 28, 1906, at the museum building of the New York Botanical Garden, at 3:30 P.M. In the absence of President Rusby, Dr. H. L. Lighthipe was called to the chair.

The following scientific program was presented:

Some Costa Rican Orchids: Mr. GEORGE V. NASH.

The speaker referred to the little known country of Costa Rica, and the desirability of securing material from there. Mr. Wm. R. Maxon, of the United States National Museum, during the early part of the year, made an exploration in this region in the interests of the New York Botanical Garden, and brought back with him, not only a valuable collection of herbarium material, but also a large collection of living plants, representing mainly the orchid, fern, bromeliad and cactus families. This material, owing to the care taken by Mr. Maxon in collecting and packing it, arrived in excellent condition. A great many orchids were among the lot, and several of these have already flowered, revealing new and interesting species. Living material is especially desirable in this family of plants, as the color and shape of the flowers play a large part in their classification, and these characters are difficult to determine from dried material. The genera *Pleurothallis, Elleanthus* and *Zygostates* have each already yielded one species new to science. The new species of *Zygostates* is a particularly interesting discovery, as it proves not only to be a species hitherto unknown, but also brings into the flora of North America a genus known formerly only from Brazil and Peru. Among other things worthy of note are: *Warscewiczella Wendlandii discolor,* originally described and known only from Costa Rica; *Maxillaria iridifolia,* found throughout tropical America, but certainly differing much in general appearance from the other members of the genus; and *Cycnoches Rossianum,* originally described from a plant which flowered in cultivation in the Garden of Mr. Ross, at Florence, Italy, in 1889. The origin of this plant was unknown, and it is now interesting to have its home revealed in this collection of Mr. Maxon's. The remarks were illustrated with living plants of the species referred to, supplemented with herbarium specimens, drawings and material preserved in formalin.

The Sedges of Jamaica: Dr. N. L. BRITTON.

Dr. Britton exhibited specimens of all species of Cyperaceæ known to occur on the island of Jamaica, including several species new to that island, collected by Professor Underwood, or by himself during a visit to Jamaica in the month of September. He remarked on the distribution of many of these species, and on the fact that a number of them are found in the West Indies only in Jamaica, their further distribution being Central America and South America. This distribution of these sedges is paralleled by that of a considerable number of species in

other families, so that the South American relationship of the Jamaica flora is more intimate than that of Cuba, Hayti or Porto Rico, and it is suspected that this may be an indication of a former land connection between Jamaica and the continent to the west or southwest. Dr. Britton's paper included a complete enumeration of the species now known, together with diagnostic keys for their determination and as much of their synonymy as relates to Jamaican records. No undescribed species were found, but the collections made by recent explorers added a number to those recorded by Mr. Clarke in his monograph of the West Indian Cyperaceæ, published in the second volume of Professor Urban's 'Symbolæ Antillanæ.'

Exhibition of Photomicrographs of North American Woods: Dr. C. Stuart Gager.

Numerous specimens were shown from a collection of photomicrographs of cross-sections of North American woods, recently acquired by the garden from Mr. James A. Weale, of the firm of Williams, Weale & Co., of Liverpool, England. These photomicrographs are all enlarged ten diameters, thus facilitating comparison. They are of very superior quality, so that many finer elements of the histology of the various woods can be demonstrated under a lens with nearly as great satisfaction as from the original sections. They possess the advantage of being less fragile than the sections themselves, and of serving better than they for purposes of demonstration before classes and otherwise. The collection contains representations of practically all North American species.

By way of comparison, specimens were shown of Hough's 'American Woods' and of Nördlinger's 'Holzquerschnitte.'

C. Stuart Gager,
Secretary.

The American Chemical Society. New York Section.

The second regular meeting of the session of 1906–7 was held at the Chemists' Club, 108 W. 55th St., on December 7. The present councilors, Messrs. Leo Baelkeland, F. D. Dodge, T. J. Parker, W. J. Schieffelin and Hugo Schweitzer, were reelected.

The following papers were presented:

A Necessary Modification of Volhard's Method for the Determination of Chlorides: M. A. Rosanoff and Arthur E. Hill.

The authors set forth the advantages of filtering off the insoluble silver chloride formed in the reaction demonstrating by experiment the indefinite end point obtained when this is not done. The subject awakened considerable discussion among several members present who had made many determinations by Volhard's method and who questioned the advantage of the modification.

The Color Change in Chromic Chloride Solutions: Arthur B. Lamb.

The speaker showed, by an experiment on the lecture table, that the change in color from green to violet of a solution of green chromium chloride was accelerated by adding a salt of a weak acid like acetic and greatly retarded by adding a strong acid as hydrochloric. The application of the principles of the ionic theory to this and related transformations was dealt with at some length. Attention was called to the explanation, afforded by this investigation, of some results by Weinland and Koch, showing the varying amount of chlorine precipitated from solutions of green chromium chloride by different silver salts.

Some New Double Phosphates: L. J. Cohen.

The properties of a number of salts of phosphoric acid were described and their analyses compared with the theoretical.

Note on a Strange Case of Poisoning: M. T. Bogert.

A case of poisoning in the distillation of certain bromine compounds, where deep destruction of tissue, with no apparent external injury, was caused by very brief contact of the hand with the vapors. Professor Bogert further spoke of the desirability of calling attention to injuries received in handling corrosive materials in order that suitable precautions might be taken by future investigators.

C. M. Joyce,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE TEACHING OF CRYSTALLOGRAPHY.

SEVERAL weeks ago Professor A. F. Rogers called attention through the columns of this journal[1] to a number of points concerning the teaching of crystallography, especially as a part of the work in an *elementary* course in mineralogy. In order to discuss Professor Rogers's paper, the end to be attained by such a course must be clearly understood. If the work in the *elementary* or *beginning* course has as its object the training of professional crystallographers much may be said in favor of a course similar to the one outlined by Professor Rogers. If, however, on the other hand, the course is to be only a part of the general education of the geologist, chemist, civil or mining engineer, forester, or teacher of science in the secondary school, the practical side of the work must be emphasized as much as possible. In such a course crystallography must, hence, be considered simply as a means to an end, that is, it should train the student in the rapid recognition of crystal forms. The handling of a large number of forms—models and crystals—tends to train the eye better than do extended discussions concerning the measurement, calculation, and projection of crystals.

The question which confronts most students of mineralogy—here it may be mentioned that in most institutions where mineralogy is taught at all only a very small percentage of the students have time to pursue more than the elementary course—is the rapid determination of minerals and, hence, theoretical considerations, which are of vital importance to the crystallographer, may in general be dispensed with. To be sure, some theory must be given, but all the theory necessary can be readily given by means of lectures and the laboratory work devoted entirely to the acquiring of a comprehensive knowledge of forms by contact and inspection rather than by analysis. (Formenanschauungsunterricht of von Groth.)

The writer agrees with Professor Rogers that the classification of crystal forms based upon symmetry is the best to use even with beginners, but would add that the older ideas of holohedrism, hemihedrism, etc., should—even though there be no structural connection between such forms—be retained on account of the many advantages they offer in acquiring a clear understanding of the forms possible in the various classes of symmetry. That these advantages are recognized as of considerable importance, it may be well to state that most of the German texts on crystallography, *designed for beginners,* retain them; among such works those of Bauer (1904), Bruhns (1904), Klockmann (1903), Linck (1896) and Naumann-Zirkel (1901) may be mentioned.

It is also common practise with German mineralogists to follow the older methods in the *elementary* course of instruction and treat the cubic or isometric system first and then the others in order. Even von Groth, who is no doubt one of the strongest advocates of the newer classification, retained to the knowledge of the writer, who was a student in his laboratory during the years 1899–1901, the older method of treatment (including holohedrism, hemihedrism, etc.!) in his beginning course rather than discuss the forms as outlined in his 'Physikalische Krystallographie,' the third edition of which had appeared several years before, namely, in 1895.[2] In fact Professor von Groth was accustomed to state in an introductory lecture that from the theoretical point of view the order as outlined by him—begin with class of lowest grade of symmetry and discard ideas of holohedrism and so forth—was the natural one to follow, but that certain practical and pedagogical reasons demanded that the reverse order be pursued especially when discussing crystallography with *beginners.*

There is no denying the fact that the measurement, calculation and projection of crystals are of great value to obtain a clear insight into the true meaning of crystallography and, hence, ought to be pursued by at least all

[1] N. S., Vol. XXIV., pp. 620–621.

[2] Compare Bruhns, 'Elemente der Krystallographie,' 1904, preface and foot-note on page 2. Also Baumhauer, 'Die Neuere Entwickelung der Krystallographie,' 1905, pp. 26–53.

graduate students in geology, chemistry and physics. But such work should follow the introductory course. In this advanced course a full treatment of the Miller indices, axial ratios, etc., finds its proper place. Would it not be the height of folly to recommend that extended philological researches be introduced into the beginning course of one of the modern languages? At any rate, Professor Rogers's statement that 'without something of the sort (meaning crystal measurement, calculation and drawing) the time given to crystallography may almost be a waste of time unless it is taken up at some future time' is to my mind altogether too sweeping and certainly needs qualification. I would like to ask what student of mineralogy has not found a course in elementary crystallography of the highest value and interest, even though it did not include the work supposed by Professor Rogers to be of paramount importance.

Edward H. Kraus.
Mineralogical Laboratory,
University of Michigan,
November 20, 1906.

CHAMBERLIN AND SALISBURY'S TEXT-BOOK OF GEOLOGY.

The review of the three-volume 'Text-book of Geology' by Professors Chamberlin and Salisbury in a recent number of Science, is likely to convey to the general reader an erroneous impression of that publication. Certain idiosyncrasies of style and little errors of detail, some of which are not real, are dwelt upon at such length that one becomes imbued with the idea that such mistakes are abundant and that they detract largely from the value of the text. It is natural that in a book of this size a number of things may be found worthy of criticism, and especially is this true of little matters which are likely to escape notice in reading the proof of the first edition. Mistakes of this class are better brought to the attention of the authors through the medium of a personal communication than by making them the subject of complaint in the public prints. Enough of such details can be found in any work to convey a wrong impression of the whole, if they are given so large a space that the main features of the work receive subordinate notice. It should be the function of a review to give the reader a correct understanding of the important and readable qualities of the book, whether they are good or otherwise, and not simply to recount trivialities. While in this case the reviewer finally gives adequate expression of his appreciation of the high value of the books concerned, this expression is prefaced by so many criticisms of details that the effect of his commendation is largely lost.

Some of the criticisms affect mere oversights in proof-reading, which are bound to occur in any publication of this magnitude. Several of these have been corrected in the second edition of volume I. Such an error was the use of 'syncline' for 'anticline' as pointed out by Dr. Branner.

A large number of the specific faults mentioned in the review are found on closer inspection to be imaginary rather than real, and one is forced to conclude that the reviewer was somewhat hasty in his perusal of the text. Of this nature is the criticism of the statement that "theoretically the rotation of the earth should increase erosion on the right bank of streams in the northern hemisphere and on the left bank in the southern," because "no reference is made to the direction of the streams," for this tendency is not dependent upon the direction of the streams, and the authors were correct in leaving their statement unqualified in this particular.

The reviewer takes exception to the statement that the advent of the Ammonites occurred in the Permian and cites Monograph XLII., U. S. G. S., as showing that they were abundant in the coal measures. The genera described in that work, however, belong to the types most widely known as Goniatites and Ceratites, the occurrence of which was duly mentioned by the authors. These are ammonoids, of course, but not Ammonites as the term is generally understood. The specific statements of the authors are therefore discriminative.

The statement of the authors that 'differences in density of sea water are due to differences in temperature and salinity' is criti-

cized on the ground that salt is not the only mineral in solution. Probably few students would understand 'salinity' to refer solely to common salt, since it is commonly used in its broader sense in scientific treatises.

It is a matter of surprise that Professor Branner should say that 'no mention is made of increase of temperature' in connection with the deposition of mineral matter from solution, for the influence of temperature on solution and deposition is distinctly recognized by the statement that 'reduction of temperature often causes deposition' with the added statement that 'in general, hot water is a better solvent of mineral matter than cold,' with the further recognition in a footnote (p. 213, 1) of exceptional cases, lime carbonate being specified. The statement might have been more fully explained, but doubtless the authors had in mind at all times the necessity of keeping the length of the treatise within reasonable limits.

The reviewer makes the authors affirm that 'the deposition of mineral matter from boiling water is the same process as that by which it is deposited upon evaporation.' The statement in the text is that 'the process of deposition by evaporation is illustrated when water is boiled,' which is obviously true. The statement might have been made clearer by amplification; yet there is no reason to give the abbreviated statement an adverse interpretation.

Complaint is also made that 'in discussing river terraces' (p. 198) 'no mention is made of a stream swinging back and forth across its flood plain.' On the page cited only the exceptional modes of terrace-formation are outlined, whereas if the reviewer had glanced at pp. 196–197 he would have found the normal process of terrace-making fully discussed.

Another group of criticisms is based upon misinterpretation of the text, where the true meaning is obvious upon careful reading. Perhaps the authors might have explained their statements, so as to forestall all possible misinterpretations, thus increasing the size of the volumes, but no doubt it was expected that the student would find the correct interpretation from briefer statements which were sometimes capable of being twisted into another meaning.

With reference to the statement that 'faults rarely show themselves in the topography of the surface' the reviewer says that 'a California geologist could hardly be expected to uphold such a statement with a straight face.' The original sentence is 'since faults rarely show themselves in the topography of the surface, their detection and measurement are usually based on the study of the relations of the beds involved.' Topographic features which are known from other evidences to have arisen from faulting, but which could not be proved to have originated in that way except by the other means indicated, are clearly not embraced in the statement. On a previous page, fault scarps are discussed and the fact stated that they are, before they become obscured by erosion, notable topographic features. While it is unquestionably true that in some parts of the world recent fault scarps are still prominent, it may also be affirmed without hesitation that the vast majority of faults have no topographic expression.

In discussing the formation of deltas, the statement is made in the text that 'the projected stream current is ineffective, all load except that in suspension is dropped and a depositional slope is established.' The reviewer assumes that matter in solution is meant, whereas obviously the material rolled or pushed along the bottom is referred to. This is clearly implied by the context, for a little below it is stated that 'the finest sediment will be carried beyond the steep slope and conform to the topography of the bottom beyond.' The wording of the sentences could have been improved and has been so altered in the second edition of volume I., which the reviewer seems not to have had before him.

The criticism of the authors' statement with reference to fiords is hardly deserved, since subsidence is explicitly recognized as a factor in fiord-making in several places in the volumes. On the particular page cited the question of the effect of glaciation in the development of fiords was the special case under discussion.

Most of the above criticisms relate to small

matters, but the following touches one of much importance. The reviewer says that the reasons are not clear for the inference that 'a vegetal covering of the land extended as far back in the history of the earth as clay slates, quartzose sandstones and limestones formed the prevailing sediments.' He proceeds to give reasons for thinking that decomposition and the deposition of limestone may take place without the aid of vegetation, overlooking the meaning of the phrase 'the *prevailing* sediments,' and that of the context, in which it is stated that "if the surface be bare of vegetation, the crystalline rocks are usually disaggregated before they are decomposed, since destructive action occurs best at the junctions of crystals and along cleavage lines and hence the crystals are usually separated from one another before they are fully decomposed. In the absence of a covering to hold them in place until they are decomposed they are apt to be washed away, and the resulting deposit consists in considerable part of grains of feldspar, mica, hornblende and other minerals which do not usually occur in well decomposed sediments." It is difficult to see how a careful student can fail to note that there is here a recognition of decomposition, on a small scale, independent of vegetation. The point to be emphasized was, on the other hand, that in the absence of the protection of a vegetal covering mechanical disintegration so far overpowers decomposition that in most cases the disaggregated particles on the naked surface are carried away by erosion, and give rise to a formation which is only partially decomposed. When, therefore, the 'prevailing formations'—not exceptional or possible ones—consist of the products of *mature decomposition* (II., p. 199, where the matter is again stated) it is reasonable to suppose that the land possessed a vegetal covering.

The authors are scored for not treating the Pacific coast geology of Mesozoic and Tertiary times more fully. It may be that they would reply that it is because relatively few good sections of the strata of the Pacific coast have been published. Nevertheless, sections from that part of the country, illustrating the systems referred to appear as figures on no less than twelve pages in volume III. and additional columns are furnished at the close of that volume. These sections receive as much consideration in an interpretative way as one could expect in a treatise so cosmopolitan in its field. Not improbably the geologists of Dakota think that the geology of Dakota has not received adequate recognition, while the geologists of Texas have the same feeling with reference to the geology of their state, and so on indefinitely. It is but natural that those regions which have been most thoroughly investigated should receive the largest share of attention.

It is in view of such points as these that the reviewer takes occasion to say that 'these are oversights which must annoy teachers of geology.' It is the present writer's observation, in using these volumes as a text-book with students, that the number of misinterpretations put upon the text is extremely small; and while teachers of geology may regret any and every imperfection in the volumes they may well be gratified that so complete and readable a treatise is now available.

Eliot Blackwelder.

University of Wisconsin,
November 7, 1906.

THE DETERMINATION OF THE TYPES OF GENERA. A CORRECTION.

In my recent article on the 'Determination of the Types of Genera" the sentence,[2] "As *gryphus* was the last species removed from the genus *Vultur* it is its type by elimination * * *," requires modification. In reality *gryphus* was the second species removed from the genus, but the last species to be disposed of by assignment to a special genus of its own, which is the statement intended. From the modern standpoint, no two of the original six species of *Vultur* were congeneric, and *gryphus* was the last species to be provided with a distinctive generic name.

J. A. Allen.

[1] "The 'Elimination' and 'First Species' Methods of Fixing the Types of Genera," Science, N. S., Vol. XXIV., No. 624, pp. 773–779, November 14, 1906.

[2] Page 776, at middle of first column.

SPECIAL ARTICLES.

CHARACTER OF THE BACTERIAL FLORA OF CARNIVOROUS AND OF HERBIVOROUS ANIMALS.

IN the course of the study of anaerobes of the human intestine it appeared desirable to learn something about the characters of the bacterial flora inhabiting the large intestine of various domestic and wild animals. It was noticed that in the dog, which is frequently exclusively carnivorous, the intestinal contents often showed the presence of large numbers of spores, spore-bearing bacilli and vegetative forms of anaerobes. The numbers present in the feces were noted to be especially large in some animals which had been exclusively fed on meat. A study of a grown cat fed upon raw meat showed the presence of Gram-positive vegetative anaerobes from one end of the digestive tract to the other. Flora derived from the stomach, small intestine and large intestine were inoculated and grown in bouillon flasks and showed an abundant production of methyl mercaptan as well as hydrogen sulphide. The numbers of colon bacilli present in this case were relatively small as compared with the anaerobes. The study of the colonies obtained on anaerobic plates showed that a large portion of the organisms present in the intestinal tract were *B. aerogenes capsulatus*. Intravenous infusion of these organisms into a rabbit which was afterwards killed and incubated showed in a high degree the typical gas-formation.[1]

Observations on other cats showed the presence of considerable numbers of spore-holding bacilli and free spores, sometimes in chains, in addition to vegetative forms of anaerobes. The position of these spores and spore-holding bacilli has not been established in a bacteriological sense. Observations were also made upon the intestinal contents of the wolf, tiger and lion. Several different tigers were studied and the observations were not confined to the examination of one lion and one wolf. The material from the lion showed the presence of many free spores. It also showed the presence of considerable numbers of Gram-positive bacilli, suggesting *B. aerogenes capsulatus*. Gram-stained preparations from wolves showed findings similar to those observed in the lion except that the spore-holding bacilli were more numerous. The findings in the case of supposedly healthy tigers were not essentially different from those in the case of the wolf and lion. In the case of one tiger, suffering from osteomalacia, greatly impaired nutrition and loss of strength, the microscopical fields derived from several different samples of feces revealed the presence of immense numbers of free spores and smaller numbers of immature Gram-negative spore-holding bacilli. These spores developed into organisms which possessed all the generally known cultural and biochemical characters of *B. aerogenes capsulatus*, including the ability to develop a high grade of gas-formation in rabbits injected and incubated.

It was found that bouillon cultures of the mixed fecal flora from the lion, tiger, wolf and cat all developed quickly a sufficient quantity of methyl mercaptan to give promptly a very well developed reaction with isatin-sulphuric-acid.

Experiments were made with the mixed fecal flora from these carnivorous animals to determine their pathogenicity when injected into the subcutaneous connective tissue. It would have been better to have worked with pure cultures of the anaerobes in question, but opportunity has not yet arisen to isolate them. The result of the inoculations into guinea-pigs was the same in each instance. The animals died within twenty-four hours and usually in fifteen to eighteen hours. At autopsy the subcutaneous connective tissues

[1] The incubation method of Welch and Nuttall is based on their observation that the gas bacillus produces gas abundantly in the blood, organs and tissues of rabbits killed a few minutes after intravenous injection. Here the blood and tissues of the rabbit act as a peculiarly favorable culture medium for the growth of the gas bacillus, the latter having been thoroughly spread by the blood through the body, and the conditions being anærobic. A suspension of the feces to be tested is prepared by grinding 1 gram of the fresh material with 9 c.c. of 0.85 per cent. salt solution and filtering through absorbent cotton. One or two cubic centimeters of this suspension are then injected intravenously into a rabbit which is quickly killed and incubated for five hours at 70°C.

were hemorrhagic, œdematous and showed necrotic changes which extended in some instances to the muscles. Gas-formation was not usually noted as a prominent feature. These pathological alterations were not confined to the site of inoculation but had extended to the subcutaneous connective tissues throughout the body and were especially pronounced in the axillæ and in the groin. It is unnecessary to enter here into the details as to the character of the organisms recovered from these lesions.

We may contrast with these findings the observations made upon herbivorous animals, including the buffalo, goat, horse, elephant and camel. In the case of the camel, elephant and horse the preponderant bacteria in the Gram-stained fields were small Gram-negative organisms which were regarded as special forms of *B. coli*. In the case of the goat the fields contained some Gram-positive bacteria and of the Gram-negative ones a considerable number were of considerably greater length than the dominant small forms which were regarded as belonging in the class of colon bacilli. In the case of the buffalo, mixed fields were found as regards the Gram-staining and many of the positive organisms were found to be small diplococci and small bacilli. In none of these animals were seen any organisms suggesting *B. aerogenes capsulatus* excepting in the case of the buffalo where the number of bacilli of this type was very small. Spore-holding organisms were not observed, but moderate numbers of free spores were noticed in all the fields except those from the elephant. In the fields showing the largest number of spores their occurrence was far less frequent than in the lion, tiger, wolf or cat.

The mixed flora of these different herbivorous animals, grown upon peptone bouillon, failed to show the production of methyl mercaptan excepting in the case of the horse, where a moderate reaction was obtained.

Observations were also made upon the effect of suspensions of the mixed flora from herbivorous animals when injected subcutaneously. The quantities of suspension used were usually about twice as great as in the case of the suspensions from the carnivorous animals. With the exception of the suspensions obtained from the horse, the pathogenicity of these suspensions was found to be slight, the guinea-pigs frequently living two or three days or entirely recovering. In the horse were found hemorrhagic and œdematous lesions with necrosis, similar to those found in the carnivorous animals. These lesions were, however, less pronounced than in the case of the suspensions from the carnivorous animals. In the case of the elephant a considerable quantity of fibrinous exudate was found about the point of inoculation. No œdema or necrotic change was observed in the subcutaneous tissues.

A further confirmation of the radical differences existing in the intestinal tracts of carnivora and herbivora is furnished by a series of observations with the Welch-Nuttall incubation test. Suspensions were made from the feces of all the types of animals mentioned and equal quantities of these suspensions were infused intravenously into a series of living rabbits. The rabbits were then quickly killed and incubated. On examination after twenty-four hours it was found that all the rabbits infused with suspensions from carnivora showed in an extreme degree the characteristic putrefactive changes in the liver, cellular tissues, etc., induced by pure cultures of *B. aerogenes capsulatus* or of the bacillus of symptomatic anthrax. The rabbits infused with suspensions made from the feces of the herbivora showed similar but very much slighter changes in each case. The results for each group of animals separated the herbivora sharply from the carnivora. Examination of the livers showed the number of bacteria in the carnivorous series to be many times greater than in the herbivorous series. The microorganisms were regarded as being almost certainly *B. aerogenes capsulatus* on account of their morphology and failure to sporulate. The bacilli of symptomatic anthrax readily sporulate in the incubated rabbits. The gas-bacillus (*B. aerogenes capsulatus*) does not sporulate under these circumstances.

These differences in the appearance and behavior of the bacteria derived from typical

carnivora and herbivora suggest that the habit of living upon a diet consisting exclusively of raw meat entails differences in the types of bacteria that characterize the contents of the large intestine. The occurrence of considerable numbers of spore-bearing organisms in the carnivora points to the presence of anaerobic putrefactive forms in great numbers. The results of subcutaneous inoculations into guinea-pigs bear out this view and indicate that the numbers of organisms capable of producing a hemorrhagic œdema with tissue necrosis, with or without gas-production, are very considerable. Unfortunately, the data pertaining to the biological properties of these pathogenic anaerobes are at present insufficient to permit us to classify them or to say more of their nature than that they are organisms representative of a definite group of putrefactive anaerobes which make butyric acid and hydrogen and exert a peptonizing action upon living tissues. Nevertheless, the observations here recorded are of much interest in relation to the bacterial processes and nutrition of herbivorous[2] as distinguished from carnivorous animals and are significant furthermore for the interpretation of bacterial conditions found in man. The question arises whether the abundant use of meat over a long period of time may not favor the development of much larger numbers of spore-bearing putrefactive anaerobes in the intestinal tract than would be the case were a different type of proteid substituted for meat.

Inquiries made of Dr. Blair, the pathologist at the New York Zoological Park, elicited the fact that while, upon the whole, the carnivorous animals are apt to live somewhat longer than the herbivorous animals of about equal size, the carnivora are much more likely to develop conditions of advanced anæmia in the later years of their lives than is the case with the herbivora. Dr. Blair states that it is usual in the later years of life for the carnivora to show a much diminished volume of blood and at least a moderate fall in the hemoglobin. Instances are stated to be not uncommon in which a pernicious type of anæmia has developed in the carnivora. On the contrary, among the herbivora it is said that pronounced anæmias are very occasional. The examples of severe anæmia encountered among the herbivora were said by Dr. Blair to be in nearly all instances referable to gross animal parasites.

The information now available indicates that man occupies a position between the herbivora and carnivora with respect to the numbers of putrefactive anaerobes that are present in the digestive tract and their proportion to the total number of bacteria. The influence of a purely vegetable diet on the one hand and of a strict meat diet on the other, upon these anaerobes, is much in need of careful investigation.

C. A. HERTER.

[2] Many of the herbivora yielded mixed flora incapable of making gas on dextrose bouillon.

THE EXCEPTIONAL NATURE AND GENESIS OF THE MISSISSIPPI DELTA.

AT the December meeting of the Cordilleran Section of the American Geological Society, 1905, I read a paper under the above title, an abstract of which, printed on the program, is copied below:

> This paper discusses the wholly exceptional materials and form of the lower delta of the Mississippi river, as observed by the writer in 1867 and 1869, and described and discussed in the *American Journal of Science* in 1871. Following out the suggestions of Lyell, and the disputed statement of Humphreys and Abbott that the alluvial deposits of the great river are only of slight depth, the writer investigated the extreme mouths of the Passes, the 'Neck' and the similar minor, bird-foot-like arms projecting beyond. It became apparent that the silty river deposit on these narrow dikes or banks is only superficial, and that their resistance to erosion during overflows is due to their being mainly composed of tough, inerodable 'mudlump clay.' That these mudlumps, observed and described by Lyell, are upheavals of the river bottom, and are formed of such clay as is deposited *outside* of the bar, where the turbid water of the river meets, and is clarified by, the saline sea water. Also, that the mudlump upheavals occur in the *main* outlets or passes of the river, as a direct result of their being the main outlets. No mudlumps then existed in the South Pass, but now that it has been artificially made the main channel, mudlump upheaval has taken, and is taking, place. Mudlump formation is thus

the normal mode of progression of the delta of the main Mississippi.

No such phenomena are known to occur in any other river of the world, hence no other river has such birdfoot mouths. The Mississippi delta should not, therefore, be longer presented as the type of a normal delta, as is done by Russell in his 'Rivers of North America.'

The above paper was not written out for publication, as I then thought it sufficient to have called the attention of geologists to the omission of so exceptional and unique a feature, already elaborately discussed by Sir Charles Lyell in the tenth edition of his 'Elements' (pp. 448–454), and belonging to the principal river of North America. I find the same misconception and omission, however, in Chamberlin and Salisbury's 'Handbook of Geology'; hence it seems desirable to call attention more pointedly, as was suggested to me by Russell, shortly before his death.

Upon the 'correction' of the mouths of the great river, rendered necessary by the peculiar phenomenon of the mudlumps, the government has in the past been obliged to spend many millions. It is still compelled to keep dredgers constantly at work, notwithstanding the fact that the enormous volume of the river has been turned into the single channel of the 'south pass' of the delta. Why does not the scouring action of the current keep this channel permanently open, once for all? And why does not the river, in its twice-annual overflows, break and wash permanent lateral channels through the narrow barriers or levees that jut out into the gulf in birdfoot shape, unlike all other deltas in the world?

A simple examination of the material of which the banks of the 'passes' and of the uprising mudlumps in the channels are composed, answers these questions categorically. The material in both cases is a tough clay, wholly unlike any of the visible sediment carried by the stream; the latter forms only a thin surface layer on the main clay mass bordering and confining the currents of the river, whose scouring action is powerless so long as the clay remains permanently submerged.

Whence this clay, and why should it be brought up forcibly from the channel of the river, of all places the one where the scouring should be most effectively done?

Of this forcing-up there can be no question whatever. Pilots and ship-captains have seen the channel in which they passed to sea a short time before, completely blocked by a mass of tough clay on their return. A ship thus run aground in several feet of water in the evening has found its bow raised out of the water in the morning, requiring several tugs to pull it off backward. For years, tugs with gigantic engines pulled the entering and the sea-going ships through the tough mud, which all the dredging and artificial scouring done by the U. S. River Service could not control. Frequently the mud kept rising as fast as the dredger worked.

Soundings around newly risen mudlumps, and sometimes direct inspection, generally show them to have the form of a rounded bubble, from whose highest point there frequently issue gas bubbles, and sometimes a flow of liquid mud visible even below water. Gas bubbles were also noted whenever the dredgers disturbed a lump in the channel.

When a mudlump rises above tide level, as is frequently the case, there are usually formed on its summit one or several vents, like the craters of mud volcanoes, from which there issues a steady flow of semi-fluid mud, agitated from time to time by gas bubbles; the gas is combustible and, as ascertained by the writer, is such a mixture of marsh gas and carbonic dioxid as is evolved from organic débris in their *first* stages of decay. This gas is undoubtedly derived from the large masses of trees and other vegetable matter carried and buried by the river in its deposits. But its amount, as Lyell correctly estimated, is wholly inadequate to account for the copious and steady flow of fluid mud, which gradually builds up flat cones of solidified material, sometimes attaining the height of fifteen to eighteen feet above tidewater, but more commonly six to ten feet. Usually other craters are formed before the extreme height is reached; or several mud-bubbles coalescing may form a small island with several vents.

The latter in the end are usually choked by solidified mud; and so soon as this happens the work of destruction begins. Sometimes the lump collapses bodily, segments of circular fissures forming all over it, often leaving a small lagoon in the middle; this occurs especially where the material is not a very stiff clay, as in the southwest pass. On the eastern portions of the birdfoot area the destruction of the lumps usually occurs by the waves washing over the *dried* mud of the cones, and bringing it down, to be partly washed away, partly deposited in the intervals between adjacent lumps, connecting them and thus gradually forming a solid, continuous clay dam, on which the river current exerts no sensible eroding effects while it remains submerged.

It is in this way that the narrow bands that bound the outer passes of the Mississippi are formed and maintained, and are made to progress seaward. In other words, *mudlump formation is at present the normal mode of progression of the visible delta into the gulf.*

How far back in time or distance this mode of progression reaches is, of course, unknown at present; but the peculiar, onion-like structure of mudlumps that have risen above the surface and become mud volcanoes, should render this not a difficult problem to solve where sections exist or shall be made within the delta. The peculiar material, so different from any now deposited by the river above its mouth, and which in fact can only have been deposited in slack-water, is enough to distinguish the mudlump formation. It is this same clay that has for ages withstood the impact of the main river-current at the 'head of the passes,' whence the several outlets diverge; the same material forms the narrow banks of the 'neck,' at the head of which, where it diverges from the main delta-mass, forts Jackson and St. Philip are located. Were it otherwise, the narrow barrier separating the neck from Garden-island Bay could not have survived a dozen years of floods; whereas even the channels purposely cut through it by duck-hunters to avoid the long détour through the passes into the bays, have hardly been enlarged in fifty years.

If any more evidence were needed, it is supplied by the existence of an active mud-volcano in the marsh, seven miles above the mouth of the southwest pass, where the writer saw it spouting mudspatters and emitting mudstreams in 1869. This mudlump (then known as Morgan's lump) projected at least eight feet above the tall rushes (*Scirpus lacustris*), and rose, therefore, at least sixteen feet above the level of the marsh.

Sir Charles Lyell ('Elements,' etc., tenth edition, p. 452) inclines to carry the mudlump-genesis of the delta as far up as New Orleans, from information given him by Col. Sidell, of the River Service, U. S. Topographical Engineers. It should not be difficult to verify this in excavations made at New Orleans; mere borings can not, of course, determine the question.

As to the origin of the mudlumps, Lyell (*loc. cit.*) considers them to be formed on the principle of the 'creeps' so familiar to engineers and miners; he justly ascribes only a secondary part to the gases brought up with the mud, which according to my measurements amount to only one twentieth to one thirtieth of the volume of the material ejected. Lyell says: "The initiatory power may probably be derived from the downward pressure of the gravel, sand and sediment accumulated during the flood season off the various mouths or passes, upon a yielding bottom of fine mud and sand; materials which, as being very fine and impalpable, had long before been carried out farthest from the land." The great mass of river sediment "may well be conceived to exert a downward pressure capable of displacing, squeezing, and forcing up laterally, some parts of the adjoining bottom of the gulf, so as to give rise to new shoals and islands."

There can be no question of the general correctness of Lyell's explanation of this phenomenon, which certainly constitutes the most gigantic example of creep known, and as such should concern the geologist quite as much as the engineer. For why should the Mississippi, of all rivers in the world, *alone* exhibit this remarkable feature and mode of progression? and how, in view of the known average annual progression of the delta into the gulf (338

feet) shall we account for the continued existence of a fluid mud-layer for more than a century, in the case of Morgan's lump—why has not this mud been squeeezed dry into a sheet of clay long ago?

In my view, the entire phenomenon rests upon and is conditioned by the existence of the 'blue delta clay' and 'blue clay bottom' long commented on respectively by the engineers in charge of the river work, and the pilots off the Mississippi mouths. This blue clay constitutes a shelf reaching out about twenty-eight miles beyond the present mouths, where there is a steep descent into deep water. Wherever this clay is exposed along the gulf shore, it contains cypress stumps and other vestiges of swamp origin. It constitutes the main body of the formation which in my Mississippi report of 1860 is doubtfully designated as Coast Pliocene, but to which subsequently, finding it most characteristically developed at Port Hudson, I gave the latter name. Its existence and nature imply that swamp or marsh conditions prevailed to gulfward for nearly thirty miles beyond the present coast line, prior to the advent of the Mississippi River of to-day. Since that time the land has been depressed and reelevated to the extent of some 450 feet at least; but a prior elevation, indicated by stream-gravel beds now 450 feet below sea-level, must have thrown the Mississippi Valley drainage northward toward the Arctic, the divide between the two drainages being very low. This former northward direction of the drainage has been discussed somewhat widely before, by Tight and others, but not, so far as I know, with special reference to the gulf datum-plane and its bordering formations. The lower Mississippi River of to-day is evidently a very 'young' stream.

However that may be, the blue-clay shelf is there, and is practically water-tight and proof against erosion so long as it remains submerged and no gravel is carried by the current. It is in this respect much like the mudlump clay itself. It is constantly found by the sounding-lead outside of the river bar; but before reaching it the lead sinks slowly for some distance in a semifluid mud, which is undistinguishable from that flowing from the mudlump vents. It is manifestly the result of the precipitation of the finest clay and silt when the river water mixes with that of the sea.

In its annual advance of 338 feet to seaward, the sandy bar-material covers this fluid clay much faster than the latter can escape to seaward under the pressure. It is covered by the heavy bar-sand, which from a boat in the shallow water over the bar-crest can be seen being carried rapidly over, shallowing the water outside; while *the deepest water inside the bar is found near the base of its landward slope.* And it is just there, *i. e.,* just *inside* the bar, and not, as Lyell seems to imply, on 'the adjoining bottom of the gulf,' that the rise of mudlumps chiefly takes place; right where the strongest current seems to indicate the best channel for ships to pass. In other words, the current *excavates* the river bed immediately inside the bar, and, relieving the superincumbent pressure, thus enables the mud-bubbles to rise.

It is not clear whether Lyell considers the bar as such to exert the pressure causing the rise; it is, at any rate, difficult to see how the static pressure of a *submerged* bar could cause the same material to rise from ten to fifteen feet above tide-level.[1] But there is no doubt that the weight and wide base of the bar is able to materially obstruct, if not prevent, the squeezing of the semi-fluid mud to seaward, despite a considerable *vis-a-tergo* from landward.

Given a semi-fluid layer of mud on an impervious clay bottom, reaching as far landward as Morgan's lump at least, the source of pressure is not far to seek. The sediment annually deposited on the marsh areas above, with their heavy growth of rushes and other aquatic vegetation, supplies ample weight; and the statement of the pilots that the mudlump springs always become more active when these marshes are overflowed, adds cogency to this explanation. *The vis-a-tergo is the ever-increasing weight of the river-sediments*

[1] The specific gravity of the outflowing mud ranges from a minimum of 1.25 to as much as 1.75.

proper, deposited in the marshes above during the twice-annually recurring floods of the great river.

Among the details of the investigation, given in my article above referred to, the following are of interest as corroborative of the above explanation of mudlump phenomena. The microscopic character of the ejected *mud* is precisely that of the mud brought up by the sounding-lead from the seaward slope of the river bar. There is a mixture of fresh-water organisms and débris with marine forms such as foraminifera; but these in the mudlump ejecta are in a macerated condition. The *water* accompanying the outflowing mud, or sometimes welling up clear from old or sandy vents, shows the chemical nature of diluted sea-water subjected to maceration with decaying organic matter. That is to say, its sulphates have been reduced to iron pyrites, which is scattered in shining crystals through the mud, while the water is strongly impregnated with bicarbonates of lime, magnesia and iron, so that it turns turbid on exposure to the air. Taking the common salt as the basis of comparison, the proportion of magnesium chlorid is increased, that of potash decreased; the latter doubtless by the absorption of the base into zeolithic combination.

The *gas* from a vent on the Passe à l'Outre consisted of 86.20 per cent. of marsh gas, 9.41 of carbonic dioxid, and 4.39 of nitrogen. This approximates closely to the average composition of the gas from ordinary swamps. No oxygen was present.

The commercial importance of the formation of mudlumps is well illustrated in the history of the several outlets or passes during historic times. The earliest navigation from the gulf to New Orleans was almost wholly through the 'Passe à l'Outre,' the most northerly of the mouths, whose very name indicates its chief importance as the outlet for deep-sea vessels destined for 'outre-mer'; with the northeast pass, it remained the main outlet in use even to the first third of the past century. Then it became so contracted and shallowed by mudlumps that the northeast and southeast passes were for a while the main channels used by vessels; but these also being soon heavily obstructed by lumps, and the south pass being too narrow and shallow for deep-sea ships, the southwest pass was, during the greater part of the past century, the main outlet for navigation. Its channel being very wide and its deposits more sandy by reason of its being most nearly in line with the main river at the head of the passes, its use involved the additional difficulty of shifting sand bars. To keep a navigable channel through these and the copious mudlump formations was an endless task, and cost the government millions; besides necessitating the use of enormously powerful tugs for the shipping. After many unsuccessful attempts for permanent relief, all of which were frustrated by the rise of mudlumps, came Eads's proposition to turn the river into the south pass, the mouth of which was then free from mudlumps. While this matter was before congress, the writer called Eads's attention to the almost certainty that whenever the south pass should be made the main outlet, mudlump upheaval would surely occur. Eads replied that he hoped that the increased velocity of the current in the narrow channel inclosed by his jetties would keep it scoured out to a much greater extent than the shallow southwest pass had been, and that at any rate it should be tried as an *ultima ratio,* and allowed to go unchallenged. To this, of course, I agreed.

The event has in the end justified both Eads's and my anticipation. Not many years after the completion of the jetties and wing-dams, mudlump upheaval began inside of the south pass bar; but the watchful activity of dredgers, together with the scouring action of the full river current, are successfully keeping the channel in navigable condition, at very much less current expense, and much more effectually, than could ever be accomplished in the southwest pass.

Taken altogether, these unique phenomena characterizing the formation and progression of the Mississippi delta seem to be of sufficient importance, both theoretical and practical, to render their omission from handbooks of American geology and hydrology hardly excusable. It is expected of those who write such treatises that they should acquaint them-

selves with all previous literature on the same subjects; but notwithstanding the elaborate bibliographies now so commonly appended to papers on special topics, the crediting and utilization of the more remote publications seems in danger of falling into innocuous desuetude.

E. W. Hilgard.
University of California,
December, 1906.

CURRENT NOTES ON METEOROLOGY.

BLUE HILL OBSERVATORY.

Vol. LVIII., Part II., of the *Annals of the Harvard College Observatory* contains 'Observations and Investigations made at the Blue Hill Meteorological Observatory in the Years 1903 and 1904.' From the introduction we learn that Mr. H. H. Clayton, well known as one of the foremost meteorological investigators in the world, has completed twenty years of service at Blue Hill, and that Mr. S. P. Fergusson, who, by his skill as a mechanician and his general ability along many lines of meteorological inquiry has contributed largely to the success of the Blue Hill work, has completed eighteen years of service. The introduction also contains a review of the principal work done at Blue Hill in the twenty years since its opening, but as readers of Science are familiar with much of this, we do not summarize here. Mr. A. Lawrence Rotch, the founder of the observatory, without whose untiring devotion to his science and unfailing readiness to assume the increasing financial burden of maintaining this institution the United States would occupy a far less prominent place in meteorological advancement, may well look back on the past twenty years of work at Blue Hill with pride and satisfaction. American men of science can have but one hope and wish in connection with the Blue Hill Observatory: that its next twenty years may be as fruitful in results as the last twenty have been.

THUNDER-STORMS AND THE MOON.

Much time has been spent by various investigators in the attempt to show some relation between the occurrence of thunder-storms and the phases of the moon. The latest contribution to this discussion comes from C. W. Hissink, of Zutphen, who in the September number of 'Hemel en Dampkring' presents the results of a study of thunderstorm days in Holland for the period 1883–1903. The means for these years show so complete an agreement for different phases of the moon that there can be no question that no lunar influence is shown. Evidently the supposed connection between moon and thunder-storms depends for the results obtained upon the period which any investigator uses, and upon the length of the series of observations. When a long series of observations is available, no lunar influence is, on the whole, manifest.

LANTERN SLIDES ILLUSTRATING CLIMATE.

We note the publication, by the Diagram Company, of New Malden, Surrey, England, of the seventh issue of 'The Diagram Series,' designed by B. B. Dickinson, assistant master at Rugby, and A. W. Andrews, extension lecturer. This series comprises a considerable number of lantern slides illustrating the climate of the world as a whole, and of the separate continents. Among these we observe charts of isotherms, isobars, winds, ocean currents and rainfall. It is encouraging to see the rapid increase in the demand for such teaching materials in meteorology and climatology for use in colleges and schools.

R. DeC. Ward.

NOTES ON ENTOMOLOGY.

A most interesting and attractive paper is that of Arnold Pictet,[1] on the influence of food and humidity on Lepidoptera. A great number of experiments were made by the author on the larvæ of twenty-one different species of Lepidoptera, among them the gipsy and brown-tail moths. His results show that changing the usual food is apt to cause variation in adults. A food difficult of assimilation hinders the growth of the caterpillar and lengthens larval life; in consequence the pupal

[1] 'Influence de l'alimentation et de l'humidité sur la variation des papillons,' *Mém. Soc. Physique et d'Hist. Nat. de Geneve*, Vol. 35, pp. 45–127, 4 pl., 1905.

period is shorter and there is a scarcity of pigment at emergence, resulting in a more or less albinic specimen. Insufficience of the normal food will produce the same result. On the contrary, abundant and rich food shortens larval life, lengthening the pupal period, so that there is an abundance of pigment, and a highly colored or melanic specimen appears at emergence. Color varieties of larvæ are often associated, but not always, with color varieties of the adults. Some caterpillars feeding on the same food may be either brown or green. The development of secondary sexual characters is also influenced by the kind and abundance of food. He finds that the size of the adult is proportioned to the size of the caterpillar; and that males vary more than females. Varieties produced by feeding increase in intensity and distinctness at each generation on the same food; however, there is always some tendency to revert to the normal form. Humidity in larval life is a partial factor in melanism, but much depends upon the temperature of the humidity and the time of its application. In some cases of cold humidity paler and more spotted forms were produced in a rather dark butterfly. The variation from humidity appears mostly on the front wings, and melanism usually starts along veins. Four fine plates illustrate the results of his experiments.

Dr. O. M. Reuter has presented an important work on the classification of the Hemipterous family Capsidæ.[3] The author, who has spent much of his life studying this one family, gives a long historical, critical and constructive account of the classification of these plant-bugs. He devotes considerable attention to a criticism of Mr. Distant's work on this family. After an examination of the structures most useful for genera and higher groups, he divides the family into twenty 'divisions,' or tribes, an elaboration of his previous classification, in the 'Hemiptera Gymnocerata Europæa.' He finds the best characters for the divisions in the pronotal carina, the cell of the wing-membrane, the tarsal joints, and especially in the arolia of the claws. Genera are based largely on shape of the head and the antennæ. Following this there is a phylogeny of the family, and a 'tree' to illustrate his views.

Dr. Walter Rothschild and Karl Jordan have published a revision of the American swallow-tail butterflies.[3] It is based on the collections in the Tring Museum and that of Oberthür. Full references and synonomy are given for all species and varieties. There are descriptions of some new species and many new subspecies, mostly from South America and the West Indies. Three new names are given to forms from the United States: *P. thoas* subsp. *autocles* from Texas; *P. glaucus* subsp. *canadensis* from Canada and Newfoundland; and *P. marcellus* subsp. *lecontei*, from various parts of the United States, to replace the *P. ajax marcellus* of Edwards, the true *marcellus* applying to the *P. ajax walshi* of Edwards.

The second report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum, Egypt, 1906, contains a number of interesting papers. Theobald makes an additional report on the mosquitoes of the Sudan. He gives also notes on the 'maggot fly' (*Bengalia depressa*), the larvæ of which live under the skin of man, and other animals; also notes on the 'Congo-floor-maggot' (*Auchmeromyia luteola*), the larvæ of which crawl at night from crevices in the floor to suck blood from sleeping persons. He also gives notes on some stingless bees, a new pupiparous fly from the ibex, some Sudanese Hippoboscidæ, a melon fruit-fly (*Dacus* sp.), and on the Dura plant-bug (*Lygæus militaris*). Mr. E. E. Austen treats of several blood-sucking Diptera, describes two new species of Tabanidæ, and gives notes on various other species.

A little-known phase of entomology is touched by K. Leinemann in his article on the number of facets in the eyes of insects.[4] He

[3] 'Die Klassifikation der Capsiden,' *Festschrift für Palmén*, No. 1, Helsingfors, 1906.

[3] 'A revision of the American Papilios,' *Novitates Zool.*, XIII., pp. 431–752, 6 plates, 1906.

[4] 'Über die Zahl der Facetten in den zusammengesetzten Augen der Coleopteren,' Dissertation, Münster, 1905, pp. 64.

has had the patience to count the facets in the eyes of 150 species of beetles. He finds that the larger the specimen, the more numerous are the facets, and that usually there is not much difference in the sexes. The male in many cases, however, has more facets than the female. In *Lampyris splendidula* the male has 2,500 facets, while the female has but 300. *Melolontha vulgaris* has, male, 5,300, female, 4,850; and *Saperda carcharias,* male, 2,200, female, 1,800. There is no general reduction in nocturnal species.

South American termites are the subject of an exhaustive paper by Dr. N. Holmgren.[5] It is based on collections made in parts of Peru and Bolivia. Out of the thirty-nine species taken, twenty-six are described as new. He adopts the genera of Wasmann. Nearly one half of the article treats of the ethology and postembryonal development; the latter subject being almost entirely new. There are chapters on swarming, the founding of colonies, the enlargement of the nest, the use of the soldier, symbiosis of different species, classification by the nesting habits, and the geographical distribution of all the species known from South America.

Dr. K. Escherich describes some interesting new genera of exotic Thysanura,[6] the most remarkable being *Assmuthia,* with two new species from India. This genus bears much general resemblance to some Collembola, with nearly equal segments, a strongly convex body, and very short anal stylets. It occurs in ants' nests.

A. Dücke publishes a supplement to his former article on the habits of Brazilian social wasps.[7] The nests of nearly ninety species are now known to him. He gives a key to the genera of South American Vespidæ, and a classification by nests and habits. Photographs of nests are on four double plates.

NATHAN BANKS.

[5] 'Studien über südamerikanische Termiten,' *Zool. Jahrb., Abt. Syst.,* XXIII., pp. 521–676, 60 figs., 1906.

[6] 'Beiträge zur Kenntnis der Thysanuren,' *Zool. Anzeiger,* XXX., pp. 737–749, 1906.

[7] 'Sobre as Vespidas sociaes do Para—Supplemento,' *Bol. do Museu Goeldi,* IV., No. 4, 1906, pp. 652–698.

BOTANICAL NOTES.

'PROGRESS OF BOTANY.'

UNDER this alternative English title Doctor J. P. Lotsy, of Leiden, has begun the publication of an annual summary of the recent advances in botany to be known under its Latin title as 'Progressus Rei Botanicae' (Gustav Fischer, Jena, 18 mk.). Only the first Heft of 317 pages has come to hand, but the prospectus promises the completion of the first volume during the present winter. Hereafter it is the intention of the editor to publish the *Heften* at intervals of about four months, the three *Heften* making an annual volume of from six to eight hundred pages. The part before us contains four articles, viz.: 'Die Ontogenie der Zelle seit 1875,' by Professor Eduard Strasburger; 'The Present Position of Palaeozoic Botany,' by Doctor D. H. Scott; 'Bibliography of Literature on Palaeozoic Fossil Plants,' by E. A. Newell Arber, and 'Les progrès de la Géographie botanique depuis 1884,' by Professor Ch. Flahault. The treatment is considerably different in these papers. The first, by Strasburger, is an admirable summary of the steps by which our present knowledge of the process of cell division, and especially of karyokinesis, has been built up by additions made by many investigators. Dr. Scott's paper is an attempt to give a sketch of our present knowledge of paleozoic plants, and his treatment is somewhat more general than the preceding one. In Professor Flahault's paper the treatment is still more general, and is much more like a somewhat popular lecture on the subject to a company of botanists who were not specialists in phytogeography. It is an admirable introduction to the present development of this branch of Botany as understood by the author of the paper. The bibliographical paper by Mr. Arber is thoroughly classified, and must prove of great service to paleobotanists.

A full review of this promising publication, which must be indispensable to every botanist,

is reserved until the completion of the volume, which is promised within a few months.

VEGETATION PHOTOGRAPHS.

ATTENTION has already been called to the admirable reproductions of photographs of vegetation issued under the editorship of Professors Karsten and Schenck, and bearing the title of 'Vegetationsbilder.' The publication consists of quarto Heften, each containing six plates, and as there are eight Heften for each volume, it follows that the latter will contain forty-eight plates. Three volumes are already completed, and five Heften of the fourth volume have appeared. With each plate is a short descriptive text covering a page or two. The Heften which have appeared during 1906 include 'Vegetationsbilder aus Kleinasien,' by Emerich Zederbauer; 'Vegetationstypen von der Insel Koh Chang im Meerbusen von Siam,' by Johs. Schmidt; 'Ameisenpflanzen des Amazonasgebietes,' by E. Vle; 'Das südliche Togo,' by Walter Busse; 'Vegetationsbilder aus Feuerland, von den Falkland-Inseln und von Sudgeorgien,' by Carl Skottsberg; 'Westafrikanischen Nutzpflanzen,' by Walter Busse. The beauty of the photographs and the admirable manner of their reproduction merit the highest praise. They must constitute an indispensable addition to every botanical library.

SHORT NOTES.

SEVERAL months ago, H. A. Gleason published in the *Bulletin* of the New York Botanical Garden (Vol. 4, No. 13) 'A Revision of the North American Vernonieae' which should go far toward clearing up the confusion regarding the species of this tribe of Compositae. Seventeen genera are recognized, of which one—*Orthopappus,* a segregate of *Elephantopus,* is new. Of the 143 species here described, 99 are referred to the genus *Vernonia,* and of these, twenty-five are new to science. No less than ten of the genera are monotypic.—The genus *Ptelea,* represented in the northern states by the well-known hop-tree (*P. trifoliata*) expands wonderfully in the west and southwest, where, according to a recent monograph entitled 'The Genus *Ptelea* in the Western and Southwestern United States and Mexico' (Contrib. U. S. Nat. Herb., Vol. X.) by Dr. Edward L. Greene, there are fifty-nine species. In this paper, fifty-five of the species are described as new. It is noteworthy that in framing names for these species, the author has most commendably not found it necessary, excepting in one instance, to make use of the names of persons.—Botanists may now read an official account of the proceedings of the international botanical congress which took place in Vienna in 1905. A committee, consisting of Professors Wettstein and Wiesner, and Doctor Zahlbruckner, has issued a thick octavo pamphlet of 268 pages, entitled 'Verhandlungen des Internationalen Botanischen Kongresses in Wien, 1905' which gives the history of the movement which culminated in the congress, its personnel, the programs of the sessions, the discussions, etc., and the resulting 'International Rules of Botanical Nomenclature.' The latter are given in French, English and German. Along with the latter is given the list of generic names ('nomina conservanda') which are to be retained, the rule of priority to the contrary notwithstanding. The pamphlet may be obtained from the publisher (Gustav Fischer of Jena) for 12.50 Marks.—The same committee has issued a similar but somewhat larger (452 pages) pamphlet under the title of 'Résultats scientifiques du Congrès international de Botanique Vienne 1905.' It is edited by Dr. J. P. Lotsy, and is published also by Fischer (20 marks). It contains twenty-seven papers, mostly in German (one in English) which were presented during the scientific sessions of the Vienna Botanical Congress in 1905. The only paper by an American botanist is one by Professor Doctor Arthur on the structure, development and classification of the Uredineae.—A little book, issued three years ago by the same German publisher entitled 'Dendrologische Winterstudien' by C. K. Schneider, should be of much value to students of trees in these days when so many are fitting themselves for work in forestry. About sixty pages are given to the general organography of trees, including their general

form, arrangement of twigs, bark, lenticels, buds, etc., and this is followed by somewhat more than 160 pages describing the species of trees arranged according to winter characters. Following this is a systematic synopsis of the species, arranged in their appropriate families. A short bibliography and a full index complete the volume of nearly 300 small octavo pages. The work is very freely illustrated with drawings or half-tones of twigs, buds, hairs, sections of buds, twigs, bark and wood.

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SCIENTIFIC NOTES AND NEWS.

The American Association for the Advancement of Science and the national scientific societies affiliated with it are this week holding, in New York City, a meeting which promises to be one of the most important and largest gatherings of American men of science. Programs of the meetings have been printed here, and there is printed above the address of the retiring president of the association, Dr. C. M. Woodward, of Washington University. There will be published in the next and succeeding issues of Science full reports of the proceedings.

Professor J. A. Bownocker, of the State University, has been appointed state geologist of Ohio to succeed Professor Edward Orton, Jr., resigned.

M. Vidal de la Blache, professor of geography at the Sorbonne, has been elected a member of the Paris Academy of Sciences in the room of the late Albert Sorel.

Major Edgar A. Mearns, known for his important contributions to natural history, who has been chief surgeon of the department of Mindanao, has been relieved from duty in the Philippines and will proceed to the United States.

Dr. Alexander Graham Bell delivered an illustrated address before the Washington Academy of Sciences on December 13 'On Aerial Locomotion, with a few Notes of Progress in the Construction of an Aerodrome.' The address was discussed by Professor A. F. Zahm, of the Catholic University, Washington, D. C., and Mr. C. M. Manly, of New York City, formerly assistant to the late Secretary Langley.

Professor R. S. Chittenden, of Yale University, will deliver a series of lectures next spring before the faculty and students of the College of Science of the University of Illinois. The general subject of the lectures will be the physiology of nutrition.

On Monday evenings in February and March Professor Henry Edward Crampton, of Columbia University, will deliver a series of lectures upon 'The Doctrine of Evolution: its Basis and its Scope,' at Cooper Union.

The first public lecture of the winter will be delivered in the Academy of Medicine, New York City, on Saturday evening, December 29. The lecturer will be Dr. Wilfred T. Grenfell, C.M.G., physician to the missions of the Labrador coast, who will take for his subject, 'The Work of a Labrador Doctor.'

A magnetic survey of Mexico is now in progress under the joint auspices of the Mexican Government and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The Mexican Government has two parties in the field under the direction of the Observatorio Astronomico Nacional Mexicano, Engineer Señor Abel Dias Covarrubias having charge of the eastern party and Señor Manuel Moreno y Anda being in charge of the western party, embracing the Pacific Coast from Manzanillo to Guaymas, inclusive of Lower California. The Carnegie Institution observer, Mr. J. P. Ault, will confine his operations to the part of Mexico north of the 25th parallel, upon the completion of which he will then proceed to Campeche, Yucatan and the Central American countries. The early completion of the general magnetic survey of Mexico being thus assured, it will be possible within the next year to construct accurate magnetic maps for the region between the parallels of latitude 20° and 49° North and meridians of longitude 65° and 125° West of Greenwich.

On the twenty-first of August last Professor Olof Hammarsten was sixty-five years

of age and in accordance with the laws of Sweden retired from the chair of physiological chemistry at the University of Upsala. A large volume, a 'Festschrift,' containing twenty-two papers on physiological and biochemical subjects had been prepared for the occasion by the friends and former pupils of Professor Hammarsten and the day was widely observed throughout the Scandinavian countries. Professor Hammarsten has been a teacher in the University of Upsala for thirty-seven years and his activity as an investigator dates from 1866. His most noted contributions deal with the coagulation of milk and of blood, with the chemistry of bile and the nature of mucin. Within each of these fields his keen observations and accurate descriptions serve as landmarks, the accuracy of which has never been successfully questioned.

AT its recent meeting in Mexico City the American Public Health Association elected the following officers: President, Dr. Domingo Orvañanos, Mexico; vice-presidents, Dr. Quitman Kohnke, New Orleans; Dr. R. M. Simpson, Winnipeg; Dr. G. T. Swartz, Providence; secretary, Dr. C. O. Probst, Columbus, Ohio; treasurer, Dr. Frank Wright, New Haven. Atlantic City, N. J., was selected as the place of meeting for 1907.

A TABLET has been placed in the rotunda of Memorial Hall, Yale University, to the memory of Elias Loomis, LL.D., who was professor of natural philosophy and astronomy in the college from 1860 to 1889, the year of his death. The tablet reads:—"In grateful remembrance of Elias Loomis, LL.D., who was graduated in 1830 from Yale College and twenty-nine years here served—1860–1889. An exact scholar, an astronomer of wide repute, in meteorology a pioneer, and a large benefactor of this university. This tablet is placed by a few of his old students to keep fresh the memory of the man and his teaching. 1906."

THE Cartwright prize of the Association of the Alumni of the College of Physicians and Surgeons of Columbia University will be awarded at commencement. This prize, which is of the value of $500, is open to general competition for an essay containing original investigations in the medical sciences. Further information can be obtained from Dr. H. E. Hale, secretary of the association, 752 West End Avenue, New York City.

THE University of Michigan has come into possession of a tract of land that with proper attention may be developed into a garden meeting all the requirements of the present-day European botanic gardens. This tract of land has been deeded by Dr. Walter H. Nichols, '91, and Mrs. Esther B. C. Nichols, '94. It comprises about thirty acres, and adjoins Forest Hill Cemetery on the east, having a frontage of about fifteen rods on Geddes Avenue. The land is separated from the Huron River by an approximately equal area owned by the city of Ann Arbor. By an agreement entered into by the regents of the university and the council of the city of Ann Arbor, the two pieces of land mentioned are to be developed as one, thus insuring a garden and park of at least sixty acres. This area will not make one of the largest gardens in the world, but it will make one of the large gardens of the world. It will be the same size as the St. Louis and Edinburgh gardens, nearly as large as the Paris garden, but much smaller than the New York garden, the Arnold Arboretum of Harvard University, the Kew gardens of England and the Buitenzorg garden maintained by Holland on the island of Java, each of which has over 200 acres of land, the last 1,100 acres. The following four aims for its use will be observed in the development of the garden: (1) teaching, in which students are instructed in the various orders and functions of plants; (2) scientific, in which genetic relationship is studied and experimental work is carried on; (3) economic, in which collections of medicinal and economic plants are made, and the effect of horticulture and agriculture is shown, and (4) esthetic and popularly educational, in which landscape effects are introduced and special provision is made to make the plantings, the drives and walks of interest and value to the public.

MEASURES have been taken by the Connecticut Academy of Arts and Sciences to affiliate

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with Yale University. At a recent meeting it was voted that the academy was willing to enter into an agreement with Yale. The gist of the proposed agreement is that the university will pay to the academy the sum of $1,500 annually toward defraying the expenses of publishing the 'Transactions,' which will hereafter be issued under the title of 'Publications of Yale University.' The academy, on its part, will endeavor to increase its membership, and agrees to give adequate representation on its board of officers to the various departments of study in the university that may wish to avail themselves of the opportunity to publish scientific and literary papers.

The American Public Health Association at its thirty-fourth annual meeting held this month in Mexico City, passed the following resolutions:

Whereas, A correct registration of births, marriages and deaths is necessary to indicate not only the natural increase of population, but also the measure of the health conditions and the effectiveness of sanitary operations in any country.

Whereas, With the increase in numbers, wealth and age of the populations of the several states and provinces, the necessity for evidence of births, marriages and deaths in cases of wills, pensions, insurance, crimes, etc., becomes daily of increasing urgency.

Whereas, Comparisons of the health conditions of different countries and districts and climates is only possible through the existence and study of such records.

Whereas, International comity and treaty stipulations not infrequently involve agreements touching the transmission of records relating to the births, marriages or deaths of individuals traveling or residing in foreign countries; and

Whereas, Such registration is imperfect or wholly wanting in some of the states of the countries registered in this Association, therefore, be it

Resolved, That the secretary of this association be instructed to transmit a copy of this resolution to the governors and boards of health of such states and provinces urging the desirability of effective legislation on this subject.

Whereas, The American Public Health Association is of the opinion, and has heretofore so expressed itself, that public health matters confronting the four countries embraced in this association can only be adequately administered by extending the powers and duties of their several chief executive and administrative health officers, and

Whereas, This association believes that such questions can only be satisfactorily dealt with by the establishment of a national department of health with a cabinet minister at its head in each country.

Therefore, this association, with a view to prosecute so desirable an end creates a committee consisting of three members from each of the four countries represented in the association and to be nominated by the president, the first-named member for each country to be chairman of that subcommittee and the chairman of the subcommittee of the United States to be its general chairman. This committee shall formulate what in the opinion of the Association should be the extent of the work, powers and duties of a national department of health and the subcommittee of any of the four countries shall take any steps deemed practicable by it to carry out the purpose of this resolution, and to this end be empowered to enlarge its committee as it may deem proper.

UNIVERSITY AND EDUCATIONAL NEWS.

Columbia University and Barnard College will receive $10,000 each under the will of Mrs. Annie P. Burgess. Dr. Daniel M. Burgess, her husband, will receive a life interest in the residuary estate, which will ultimately be divided into three equal parts, one of which will go to Columbia University, one to Barnard College, and the third to Hamilton College.

Plans have been drawn for the new biological and geological building of Amherst College, made possible by a $75,000 gift from Mr. Andrew Carnegie, and an equivalent amount raised by alumni and friends.

A class in general chemistry has been opened for women at Evening High School No. 73, on East Forty-sixth Street, between Second and Third Avenues, New York City. The class, which is conducted by Miss Rose Levy, is open every week-day evening except Friday and Saturday, from 7:30 to 9:30 o'clock, and is free to all who have had a public school education.

Mr. A. G. Tansley, M.A., of Trinity College, Cambridge, assistant professor of botany at University College, London, and editor of the *New Phytologist,* has been appointed lecturer in botany in succession to Mr. A. C. Seward, who has succeeded the late Professor Marshall Ward in the chair of botany.

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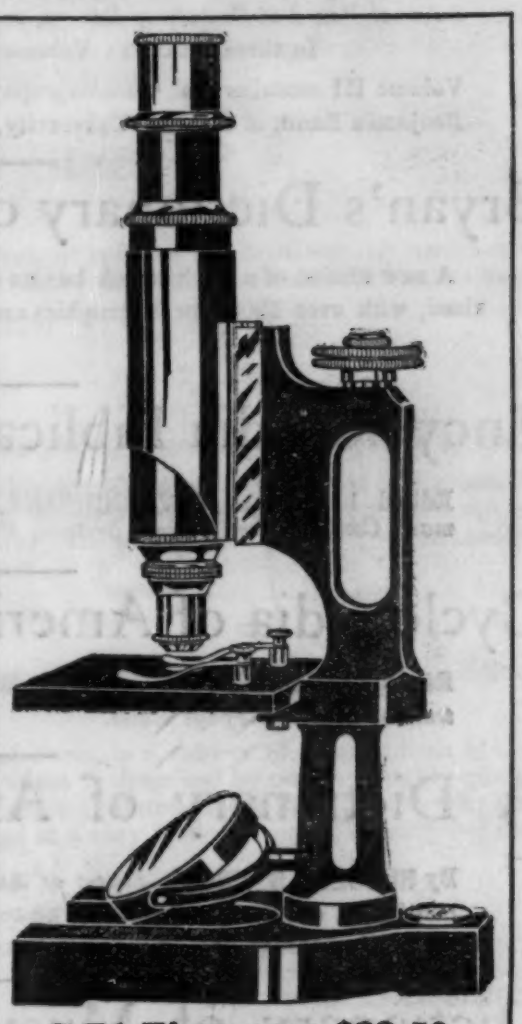

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